J. Plant Production, Mansoura Univ., Vol. 8 (2): 297 - 306 , 2017

Effect of Organic, Bio and Mineral Fertilization with Weed Control on Weed Species, Herbicides Residues, NPK Uptake by Potato Tubers and Crop Productivity.

Soliman, I. E.; S. D. M. Eid and A. A. H. Sharshar
Weed Res. Cent. Laboratory , Agricultural Res. Center, Giza, Egypt.

ABSTRACT

Both proper fertilization and integrated weed management are major components for improving potato (*Solanum tuberosum* L.) yield productivity. So, two field experiments were conducted during the two successive winter seasons of 2013/2014 and 2014/2015, Sakha Agricultural Research Station, Kafrelsheikh Governorate. Each experiment consisted of forty two treatments in split plot design with four replicates were used. The main plots included seven fertilizers combination between organic and mineral fertilizers with or without bio-fertilizer and the sub-plots contained six weed control treatments (Gesagard and Sencor as soil-acting herbicides each applied alone or combined with hand hoeing, hand hoeing twice and un-treaated check). The existed weed species in the two experimental potato fields were *Chichorium endivia*, *Medicago hispida* Gaertn and *Chenopodium album* as broad leaf weeds, *Phalaris minor* Retz. as annual grassy weed and *Cyperus rotundus* as perennial like-grass weed. The main findings indicated that all farmyard manure fertilizers application FYM at 20m^3/fed + (100 kg N, 30 kg P and 45 kg K /fed) plus bio-fertilizer combination gave the highest potato tuber yield (ton/fed) with increasing NPK uptake/ fed by 23.8, 34.0 and 26.1 % as compared with standard NPK at 200 kg N, 60 kg P and 90 kg K/fed treatment, respectively. Both Gesagard at 0.75 L/fed and Sencor at 0.2 kg/fed each plus hand hoeing once and hand hoeing twice gave the highest controlling percentage on weeds density by 90.48, 94.12 and 90.19%, and dry weight by 93.63, 90.37 and 88.09 %, respectively, at 70 days assessment, and the same trend was observed at 95 assessment increasing N, P and K % and their uptake (kg/fed) in potato tubers than un-weeded check. The effects of interaction between fertilizer and weed control treatments show that number of tubers /plant, tubers yield grade A%, tubers yield (g/plant) and tubers yield (ton/fed) were increased significantly by adding 20 m^3 farmyard manure and 100 kg N, 30 kg P and 45 kg K/fed with bio-fertilizer and (Sencor at 0.2 kg /fed or Gesagard at 0.75 kg/fed) plus hand hoeing packages. There were no residues of herbicides (Gesagard at 1.0 L/fed and Sencor at 0.3 kg/fed) were detected in potato tubers at harvest. Thus, it can be concluded from this study that combination of 20 m^3 farmyard manure plus NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer with spraying (Gesagard at 0.75 L/fed or Sencor at 0.2 kg/fed) followed by one hand hoeing, which recorded highest reduction on density weeds accompanied with increasing of NPK uptake and potato tubers yield (ton/fed), without any effect in potato tubers at harvest..

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crop for local consumption, processing and exportation in Egypt. The cultivated area of this crop reached to 381379 fed, with 4265178 tons production, with an average of 11.18 ton/fed in season 2013. (The yearly book of economic and statistics of Ministry of Agric. In Egypt, 2014). Both proper fertilization and improved weed management (IWM) are two main keys for improved management potato crop (ICM), for this reason this research was conducted.

Both organic, mineral fertilizations and bio-fertilizer balance is very needed for improving tuber yield productivity with keeping soil beneficial microorganisms healthy, where are responsible for numerous transformations in cycling elements in soil. The biomass of microorganisms can reach to several tones in soil according to Torstensson (1980). Hernot and Robertson(1994) stated that soil microbial biomass is a source and sink of soil nutrients, which may be influenced by the N transformation in soil system. Gawronska (1997) showed that mineral fertilization also strongly affects a number of microorganisms and qualitative selection of whole communities of soil microorganisms. Sarathchandra *et al.(*2001) reported that nitrogen and phosphate fertilizers had no significant effects on soil microbial populations and N application reduced the functional microbial diversity in pasture soil. Barabasz *et al.* (2002) showed that mineral fertilization of arable land increased the biological productivity of various ecosystems as well as the microbial activity in the soil. Organic manure can cause considerable increase in crop yield and exert significant influence on physical, chemical and biological properties of soil. But its use alone is not sufficient to meet the requirement of nutrients to achieve the best productivity from crop. Therefore, the use of both bio-organic fertilization and chemical fertilizers in appropriate proportions assumes special significance as complementary and supplementary to each other in crop production. The nutrient requirements of potato crop is quite high due to sparse root system and its capacity to produce large amount of dry matter per unit area. In this respect, Hussein and Radwan (2002) found that application of chicken manure alone instead of chemical fertilizer significantly increase the tuber yield per fed by 38.3 %. On the other hand, the application of a gathered group of soil microorganisms, having definite beneficial well–known role in supporting plant growth and in developing sustainable soil fertility. El-Gamal (1996) found that inoculation of tuber seeds of potato with multi strains bio-fertilizers caused a significant increment in exportable and total tuber yield of potato .

Weeds in potato fields can compete strongly with potato and can reduce yield of potato tuber by 50 - 74 % as reported by Sharshar *et al*. (2015). Presence of weeds associated with potato plants for all the season caused a significant reduction in tuber yield by 51 %/fed (Shehata *et al*., 1991).

The use of herbicides in potato field plays an important role in improving the growth of potato plants and consequently increases the productivity of unit area and decreases the cost of production as compared with hand hoeing. Evaluation of herbicides in field crop not only depending on their efficiency of controlling

weeds, but also includes the obtaining of crop growth development, high quantity and quality of yield. Panghal *et al.* (2003) found that (0.5 kg Sencor/ha, significantly controlled weeds and gave highest tuber yield compared with untreated check. Arora *et al.* (2009) found that the highest yield of potato tubers was recorded in plots treated with prometryn (0.1 kg/ha), pendimethalin (1.0 Kg/ha), metribuzin (0.5 kg/ha) and two hand weeding. No residual activity of herbicides applied to potato was found in post harvest soil. Sharshar *et al*.(2015) showed that the best treatments for controlling annual grassy and broad-leaved weeds in potato were hand hoeing twice, hand hoeing thrice and herbicidal combination of Sencor 300 g/fed + Fusilade forte 1.4 l/fed by 87.9, 95.6, 81.5%, respectively. Moreover, these treatments increased the number of tuber, average weight of tuber, number of tuber/10 kg, plant height (cm), number of main stems, yield grade A , tuber shape index, tuber dry matter, starch% and tuber specific gravity compared with untreated check. Kumar *et al.* (2013) found that application of Sencor 500 g a.i./ha recorded the maximum number of tubers plant and total tuber yield of potato crop. Kheraba *et al.* (1991) they found that the highest specific gravity was found in potato treated with Sencor, and the next highest specific gravity was found in potato treated with pendimethalin + hand hoeing. Gitsopoulos *et al.* (2014) found that Sencor 320 g a.i./ha did not cause detrimental effect on growth of potato and marketable tuber yield.

Recently, both mineral fertilization , manual weed control become constable to farmer and farmyard manure and herbicides can be replaced partially as a cheap alternative to mineral fertilization or hand hoeing in potato fields.

Thus the objective of this study, was to investigate the complementary effects between organic, mineral fertilization with bio-organic fertilization and some acting- soil herbicides with or without hand hoeing on weeds, yield and quality of potato and NPK uptake by potato tuber yield under integral treatments.

MATERIALS AND METHODS

Two experimental trials were carried out during 2013/2014 and 2014/2015 winter seasons in clay soil in Sakha Research Station, Kaferelsheikh Governorate, Egypt, to investigate the effect of some different fertilizations and weed control treatments on weeds, NPK uptake and potato crop production. The experimental soil was clay in both seasons as shown in Table 1.

Table 1. Mechanical and chemical analysis of soil.

Seasons	Organic matter %	Soil pH	Sand %	Silt %	Clay %	Textural class	N (ppm)	P (ppm)	K (ppm)
2013/2014	1.81	7.9	20.00	33.81	51.43	Clay	27.15	16.90	280.0
2014/2015	1.73	7.88	19.27	29.91	49.40	Clay	22.37	18.45	277.10

Split-plot design with four replications was used to study the effect of a combination of forty two treatments which were seven organic and mineral fertilizations treatments in the main plots and six weed control treatments in sub plots as follows:

1- Fertilizers combination treatments:

1- Farmyard manure at 30 m^3 + [50kg N as ammonium sulphate (20.6% N), 15 kg P as calcium superphosphate (15.5% P_2O_5) and 22.5 kg K/fed as potassium sulphate (48% K_2O)].
2- Farmyard manure at 30 m^3 + [50kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer (BDP).
3- Farmyard manure at 20 m^3 + [100kg N , 30 kg P and 45 kg K/fed].
4- Farmyard manure at 20 m^3 + [100kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer (BDP)..
5- NPK [150kg N, 45 kg P 67.5 kg K/fed] + bio-fertilizer (BDP)..
6- NPK [100kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer (BDP)..
7- NPK [200kg N, 60 kg P and 90 kg K/fed].

Farmyard manure (FYM) (contained N 0.40% , P 0.43% and K 1.15%) has been added during soil preparation in organic fertilization plots according to analysis done the same source, at rates (40 m^3/fed). Nitrogen and potassium fertilizations were added before first and second irrigation.

II- Weed control treatments:

1- Gesagard 50% FW (prometryne) [N,N-bis (1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine], at the rate of 1.0 L/fed, applied at 5% emergence of potato (at 21 days after sowing).
2- Gesagard at the rate of 0.75 L/fed, applied at 5% emergence of potato (at 21 days after sowing), followed by one hand hoeing at 45 days after sowing.
3 - Sencor , 70 % WP (metribuzin), 4-amino-6- (1,1-dimethylethyl) -3 -(methylthio) - 1,2,4- triazin - 5(4H) - one, at the rate of 0.3 kg/fed, applied at 5% emergence of potato (at 21 days after sowing).
4- Sencor at the rate of 0.2kg/fed, applied at 5% emergence of potato (at 21 days after sowing), followed by one hand hoeing at 45 days after sowing.
5- Hand hoeing, twice at 21and 45 days after planting.
6- Un-weeded check .

Each sub-plot were 21m^2 (6m x3.5m) including 5 rows 70 cm width and 6 meters length. The potato tuber of (Spunta tubers cv.) were planted at 25 cm apart on 13th and 18th October in the first and second seasons, respectively. Herbicides were sprayed by knapsack sprayer CP3 with water volume of 200 L/fed. All agronomic practices such as land preparation and irrigation were done as recommended.

Multi bio-fertilizers (phosphate dissolving bacteria) PDB, consisted of *Azotobacter spp*., *Azospirillum spp*. and *Pseudomonas spp*.) were prepared in Soil Microbiology Division, Sakha Agricultural Research Station by mixing highly efficient local strains of these species were applied in equal amounts of each strain broth which grown separately in specific nutrient broth for 48 hours at 30c in a rotary shaking incubator. Liquid broth cultures initially containing 9 × 10 , 2 × 10 , 5 × 10 and 3×10 viable

cell/ml of PDB, *Azotobacter spp*., *Azospirillum spp*. and *Pseudomonas* spp., respectively. Peat moss was used as a carrier for multi bio-fertilizer. Potato tubers were inoculated by this bio-fertilizer directly before planting irrigation.

Data recorded :

Weeds assessments:

Weeds were hand pulled randomly from one square meter from each plot at 70 and 95 days from potato sowing and classified into two categories (broad-leaved and grassy weeds). The weeds density/m^2 and their dry weights(g/m^2) of each group was recorded, after drying in a forced draft oven at 70°C for 48 hours. Controlling % was evaluated in the form of equation:

$$R\ \% = (A - B/A) \times 100$$

Where: A and B = The dry weight of weeds in untreated and treated plots, respectively.

On yield and quality of potato tubers:

Random samples of 10 tubers per plot were used to measure weight and diameter. Tuber specific gravity was determined by a certain weight of tubers for each plot in the air and secondly under water, then the specific gravity was computed as described by Dinesh *et al*. (2005). Total soluble solids percentage (T S S %, using hand Refractometer).

$$\text{Percentage of tuber grade A} = \frac{\text{yield of tuber grade A per plot}}{\text{Total tuber yield per plot}} \times 100$$

Based on standard tubers diameter (more than 3.5 cm) were estimated weight of all harvested tubers per plot and converted into tons per fadden.

NPK uptake:

Total nitrogen, phosphorus and potassium % were determined on the dry ground material of potato tubers which were digested in a mixture of sulfuric acid, salicylic acid and hydrogen peroxide according to (Jackson, 1958). Total nitrogen content was estimated by Kjeldahl method (Rangnna, 1979). Phosphorus and Potassium percentages in tubers were determined according to Cottenie *et al.* (1982).

Residue analysis of tested herbicides in potato tubers:

Herbicides residues for Gesagard (prometryne) and Sencor (metribuzin) in potato tubers were determined by Central Laboratory for Pesticides, Agriculture Research Center, Dokki, Giza, Egypt. according to the method of El -Beit *et al*., (1978).

Statistical analysis:

Data were statistically analyzed according to Gomez and Gomez (1984). The treatment means were compared with using the least significant differences (L S D) at 5% probability level. Bartlett test of homogeneity for error indicated that the variance of data in both seasons was insignificant. So, the combined analysis of two seasons were carried out.

RESULTS AND DISCUSSION

Effect of fertilizer combination treatments:

On weeds:

The existed weed species in this study were chicory (*Chichorium endivia* L.), bureclover (*Medicago hispida* Gaertn) and Lambsquarters (*Chenopodium album* L.) as annual broad-leaved weeds, littleseed (*Phalaris minor* Retz.) as annual grassy weed and nut-sedge (*Cyperus rotundus* L.) as perennial like-grass weed.

Results in Table 2 show that both weed density and its biomass were increased by all manure, mineral, bio-fertilizer treatments combinations than the use of mineral NPK alone at 75 and 95 days after sowing, as average of the two seasons. The highest significant values of weed densities/m^2 were obtained from farmyard manure at 30m^3 /fed plus low fertilizer rates at 50kg N, 15kg P and 22.5kg K /fed and bio-fertilizers in both the two surveys by 85.38 and 41.09 %, respectively, compared to mineral fertilizer alone.

The use of farmyard manure at 20 m^3/fed either plus 100kg N, 30kg P and 45kg K /fed and bio-fertilizer or 100kg N, 30kg P and 45kg N /fed increased of weed density/m^2 by (59.65 %) and (54.39 %) at 70 DAS, respectively as compared to control treatment. Meanwhile farmyard manure at 20 m^3/fed plus 100kg N, 30kg P and 45kg N / fed and farmyard manure at 30m3 /fed plus 50kg N, 15kg P and 22.5kg N / fed gave values by (22.5 %) and (22.21 %) at 95 DAS, respectively, as compared to mineral fertilizer. Similar trends were obtained in case of dry weight of weeds/m^2 in Table 2 where farmyard manure application at 30 m^3 /fed + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer, farmyard manure at (20 m^3) + [100 kg N, 30 kg P and 45 kg K/fed] and farmyard manure at 20 m^3/fed + [100 kg N, 30 kg P and 45 kg K/fed] gave the highest increasing values by (79.81 %), (65.01 %) and (65.01 %), respectively at 70 DAS as compared to control treatment. While, farmyard manure at 30 m^3/fed + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer, farmyard manure at 20 m^3/ fed + [100 kg N, 30 kg P and 45 kg K/fed] and farmyard manure at (20 m^3) + [100 kg N, 30 kg P and 45 kg K/fed] treatments gave the increasing highest by (95.16 %), (54.93 %) and (43.03 %), respectively at 95 DAS as compared to control treatment. These results might be due to that manure application increased weed seeds into the soil. (Zimdahl, 1999) showed that about 20% of the certain weed seeds are still viable after their passage through digesting of cattle and cow conduct to be stored in soil with manure fertilization especially weed species namely *Chenopodium album* and *Phalaris minor* and for big size seeds as *Cyperus rotundus*.

On yield and quality of potato tubers:

Data in Table 3 showed that number of tuber /plant, tuber weight, tuber yield per plant and per fed and percentage of tuber yield (grade A) were significantly influenced by different fertilization treatments. however, no significant differences were detected among the fertilization treatments on tuber diameter and specific gravity and total soluble solids of tubers.

Table 2. Effect of the fertilization on weeds density and dry weight (g) /m^2 at 70 and 95 days from potato planting (combined analysis in 2013/2014 and 2014/2015 seasons).

Weeds species	*Chichorium endivia*	*Medicago hispida*	*Chinopodium album*	*Broad-leaved*	*Phalaris minor*	*Cyperus rotundus*	*Narrow leaved*	Total	*Chichorium endivia*	*Medicago hispida*	*Chinopodium album*	*Broad-leaved*	*Phalaris minor*	*Cyperus rotundus*	*Narrow leaved*	Total
Fertilizer combination treatments (Rate / fadden)	Dry weight of weeds (g /m2)								Dry weight of weeds (g /m2)							
	At 70 days from potato planting								At 70 days from potato planting							
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	10.8	17.1	9.0	29.7	55.8	32.4	11.7	44.1	17.1	9.0	29.7	55.8	32.4	11.7	44.1	99.9
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	21.0	17.1	14.4	26.1	57.6	65.7	43.2	108.9	17.1	14.4	26.1	57.6	65.7	43.2	108.9	166.5
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	18.0	11.7	8.1	49.5	69.3	61.2	24.3	85.5	11.7	8.1	49.5	69.3	61.2	24.3	85.5	152.8
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	16.2	15.3	9.9	40.5	65.7	48.6	32.4	81.0	15.3	9.9	40.5	65.7	48.6	32.4	81.0	146.7
NPK [150 kg N, 45 kg P and 67.5kg K/fed] +bio-fertilizer	10.5	11.7	18.0	63.0	92.7	39.6	15.3	54.9	11.7	18.0	63.0	92.7	39.6	15.3	54.9	147.6
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	18.0	3.6	12.6	24.3	40.5	44.1	17.1	61.2	3.6	12.6	24.3	40.5	44.1	17.1	61.2	101.7
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	2.7	8.1	11.7	29.7	49.5	23.4	19.7	43.1	8.1	11.7	29.7	49.5	23.4	19.7	43.1	92.6
L S D at 5%	3.4	NS	NS	2.8	3.6	2.6	2.6	4.9	NS	NS	2.8	3.6	2.6	2.6	4.9	NS
	At 95 days from potato planting								At 95 days from potato planting							
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	23.0	281.7	71.0	44.1	152.8	53.1	10.8	63.9	281.7	71.0	44.1	152.8	53.1	10.8	63.9	216.7
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	34.6	144.9	25.2	60.3	230.4	49.5	58.5	108.0	144.9	25.2	60.3	230.4	49.5	58.5	108.0	338.4
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	27.0	75.5	35.1	77.4	188.0	19.8	40.5	60.3	75.5	35.1	77.4	188.0	19.8	40.5	60.3	248.3
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	19.3	81.0	37.8	89.1	207.9	22.5	38.7	61.2	81.0	37.8	89.1	207.9	22.5	38.7	61.2	269.1
NPK [150 kg N, 45 kg P and 67.5kg K/fed] +bio-fertilizer	22.8	63.0	37.8	33.3	134.1	11.7	45.0	56.7	63.0	37.8	33.3	134.1	11.7	45.0	56.7	230.4
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	18.8	75.6	33.3	75.6	184.5	26.1	19.8	45.9	75.6	33.3	75.6	184.5	26.1	19.8	45.9	190.8
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	14.4	30.6	30.6	56.7	117.0	33.3	23.4	56.7	30.6	30.6	56.7	117.0	33.3	23.4	56.7	173.7
L S D at 5%	4.1	10.1	NS	3.8	7.1	NS	NS	4.8	10.1	NS	3.8	7.1	NS	NS	4.8	11.9

Table 3. Effect of the different fertilizations combination on potato yield characters (combined analysis in 2013/2014 and 2014/2015 seasons)

Characters / Fertilizer combination treatments(Rate / fadden)	Tuber diameter (cm)	Number of tubers/ plant	Tuber weight (g)	Tuber yield (g / plant)	Specific gravity	Yield grade A	T. S. S. %	Tuber yield (ton / fed)	Increasing%
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	4.8	8.6	60.2	517.8	4.27	63.0	7.3	10.55	3.0
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	4.6	9.3	59.0	558.6	4.23	69.0	6.8	11.17	9.1
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	4.9	9.8	63.0	617.8	4.29	71.4	6.7	13.54	32.2
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	4.5	10.2	63.1	644.8	4.29	69.4	6.3	14.51	41.7
NPK [150 kg N, 45 kg P and 67.5kg K/fed] + bio-fertilizer	4.7	8.1	48.6	426.2	4.22	60.7	7.3	9.28	- 9.38
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	4.8	6.5	50.3	326.7	4.26	57.7	7.2	7.50	- 26.76
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	4.7	9.6	49.9	479.8	4.29	68.7	6.9	10.24	-
L S D at 5%	NS	1.9	6.6	69.9	NS	7.2	NS	1.4	

Addition of farmyard manure treatment at 20 m^3/fed + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer produced the highest number of tubers/plant, tuber weight, tuber yield per plant and per fed with 6.3, 26.5, 34.4 and 41.7% increases over the standard treatment (200 kg N, 60 kg P and 90 kg K/fed), respectively, following by farmyard manure at (20 m^3) + [100 kg N, 30 kg P and 45 kg K/fed], and farmyard manure at 30 m^3 /fed + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer. In contrary, [150 kg N, 45 kg P and 67.5kg K/fed] + bio-fertilizer and [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilize decreased yield by (-9.38 %) and (-26.76%), respectively as compared to control treatment. These increments might be due to that organic manure play an important role in improving physio–chemical and biological properties of soil, as well as most important features of bio-fertilizers to plant growth. In this respect, Sharma *et al*. (1988) reported that there were highly significant responses of potato to organic manures and nitrogen element. In the absence of N, the FYM was doubled the yield of large tubers but increased the yield of small grade tubers by approximately 40%. They added that, the difference between the manural and non-manural treatments on the yield became negligible at 120kg N/ha.

The superiority of the complementation fertilizer (FYM at (20 m^3/fed) + [100 kg N, 30 kg P and 45 kg K/fed] with bio-fertilizer) combination than other treatments on plant growth and yield might be due to the complementary effects between organic and inorganic

sources in the fertilizer, positively affected yield and yield components as a result of supplies soil with macro-and micro-nutrients, so improves nutritional balance in the soil which affects the relationship between plant and soil. Generally, when the bio-fertilizer, was added to the organic fertilizer, the dry matter content increased in plant tissues. Vadavia *et al*., (1991).

It can be concluded that the maximum tuber yield (ton/fed) can be obtained from the use of half recommended organic source (FYM) and the half rate of the recommend NPK as chemical fertilization treatments.

On NPK uptake in tuber yield:

Data in Table 4 illustrated that the highest NPK uptake by potato tubers was obtained from farmyard manure at 20 m^3 /fed + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer, farmyard manure at 20 m^3 /fed + [100 kg N, 30 kg P and 45 kg K/fed] and farmyard manure at 30 m^3 /fed + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer treatments increased potato tubers to uptake the largest nitrogen amounts, increasing phosphate uptake, increasing potassium uptake. This result may be attributed to the response potato plants for organic manure in the absence of N fertilizer than in the presence (Sharma *et al*., 1988). On the other hand, the relative prices and availability of fertilizer and organic manure, in the amounts needed at the place and time of requirement, will determine the economic benefits and any cost savings (Sharma and Sharma, 1988).

Table 4. Effect of the fertilizations on NPK (kg/fed) in potato tubers (combined analysis in 2013/2014 and 2014/2015seasons).

Fertilizer combination treatments (Rate / fadden)	N%	P%	K%	NPK uptake (kg/fed)		
				N	P	K
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	1.51	0.19	1.73	159.3	20.1	182.6
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	1.32	0.16	1.75	174.5	17.9	195.5
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	1.34	0.25	1.82	181.5	33.9	246.5
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	1.41	0.31	1.83	204.6	45.0	265.6
NPK [150 kg N, 45 kg P and 67.5kg K/fed] + bio-fertilizer	1.22	0.14	1.70	113.3	13.0	157.8
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	1.48	0.26	1.78	111.0	19.5	133.5
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	1.53	0.2	1.84	156.	29.7	188.5
L S D at 5%	0.21	0.07	N.S	17.39	3.05	18.6

Effect of weed control treatments:

On weeds:

Table 5 show that all weed control treatments in the two weed assessments decreased density of different weeds species which existed in potato field and confirm to a great extent which those observed in decreasing their dry weight. Depending on dry weight of broad-leaved weeds(g/m^2), Sencor (0.2 kg/fed) + one hoeing, Gesagard (0.75 L/fed) + one hand hoeing and hand hoeing (twice) treatments were decreased by 98.3, 97.7 and 92.4 % than untreated check, respectively, at 70 DAS, and Sencor (0.2 kg/fed) + one hoeing, and by 97.1, 93.5 and 92. 4 % control at 95 DAS, meanwhile *Phalaris minor* as grassy weed, Gesagard (0.75 L/fed) + one hoeing, Sencor(0.2 kg/fed)+ one hoeing and hand hoeing (twice) treatments gave 83.0, 82.1 and 75.0 % control, respectively at 70 DAS, and 91.6, 88.0 and 86.8 % , respectively, at 95 DAS. On *Cyperus rotandus* as perennial like-grass weed were Sencor (0.2 kg/fed) + one hoeing, Gesagard (0.75 L/fed) + one hoeing and hand hoeing (twice) treatments by 80.5, 72.7 and 61.0 % control, respectively, at 70 DAS, and Gesagard (0.75 L/fed) + one hoeing, Sencor (0.2 kg/fed) + one hoeing and Gesagard (1.0 L/fed) treatments by 71.1, 57.4 and 62.1 % control, respectively, at 95 DAS. The same trend was obtained in case of density of different weed species.

Superiority of this treatment against potato weeds could be attributed to the susceptibility these weeds species to studied herbicides. On the other hand, meanwhile weeds which show may tolerant the toxic effect of the herbicide can be easily removed by the complementary hoeing. Similar findings on the complementary effect between half dose of herbicide and hoeing were reported by Nadagouda *et al*. (1996).

On yield and quality of potato tubers:

Table 6 show that there were no significant differences between weed control treatments and un-weeded check with regard to their effects on tuber diameter (cm), specific gravity and T S S %. Mean while, weed control treatments increased yield components namely number of tuber of plants, tuber weight(g), tuber yield (g/plant), Yield grade A% and tuber yield (ton / fed) significantly as compared to un-weeded check. Sencor at 0.2 kg /fed plus hand hoeing once, Gesagard at 0.75 l/fed plus hand hoeing once and hand hoeing twice were the most effective treatments on increasing their characters by 71.27, 69.98 and 59.15 %, respectively, compared to un-weeded check. Similar results were obtained by *Zarzecka et al.* (1997)

Successful weed control treatments reduced below and above ground weed competition which potato plants suffer from its and consequently favored growth of potato plants and increasing their photosynthetic capacity and in turn increased the amount of metabolites synthesized by potato plants and its translocation and accumulation in plant tuber sourcing to increase growth, yield and yield attributes of potato (Sharshar *et al*. 2015). Similar results were found by Qadir *et al*. (1999) they reported that cultivation reduced tuber exposure to sunlight, which reduced tuber greening.

Table 5. Effect of the fertilization on weeds density and dry weight (g) /m^2 at 70 and 95 days from potato planting (combined analysis in 2013/2014 and 2014/2015 seasons).

Weeds species	*Chichorium endivia*	*Medicago hispida*	*Chinopodium album*	*Broad-leaved minor*	*Phalaris minor*	*Cyperus rotundus*	*Narrow leaved*	Total	*Chichorium endivia*	*Medicago hispida*	*Chinopodium album*	*Broad-leaved minor*	*Phalaris minor*	*Cyperus rotundus*	*Narrow leaved*	Total
Weed control treatments	Dry weight of weeds (g /m2) At 70 days from potato planting								Dry weight of weeds (g /m2) At 70 days from potato planting							
Sencor (0.3kg/fed)	29.7	5.4	2.7	37.8	23.4	12.6	36.0	73.8	14.4	5.4	20.7	50.5	36.7	20.0	24.7	107.2
Sencor(0.2 kg/fed)+ one hoeing	2.7	2.0	1.8	6.5	24.3	6.3	11.6	37.1	4.5	2.6	2.7	9.8	17.0	9.0	26.0	45.8
Gesagard (1.0 L/fed)	23.3	9.0	7.2	39.5	17.9	14.4	32.3	71.8	20.7	8.1	25.2	54.0	32.1	27.0	89.1	113.1
Gesagard (0.75 L/fed)+ one hoeing	5.4	1.36	4.5	11.8	16.1	8.1	24.2	36.0	7.2	1.3	5.4	13.6	16.1	12.6	28.7	42.3
Hand hoeing (twice)	3.0	8.1	1.9	13.0	14.4	9.0	23.4	36.4	3.6	12.6	27.7	43.9	23.7	18.0	51.7	85.6
Un-weeded check	66.6	77.4	76.5	220.5	83.3	73.8	157.5	378.0	214.0	90.9	272.8	577.7	94.7	46.1	140.8	718.5
L S D. at 5%	2.5	1.4	2.8	4.7	0.9	1.2	2.4	4.4	0.8	1.8	2.1	2.7	NS	2.0	3.7	7.9
	At 95 days from potato planting								At 95 days from potato planting							
Sencor (0.3kg/fed)	19.8	34.0	15.3	45.0	94.3	33.3	16.2	39.5	15.3	45.0	94.3	33.3	16.2	39.5	133.8	15.3
Sencor(0.2 kg/fed)+ one hoeing	7.2	9.0	9.0	4.5	22.5	6.3	35.9	52.2	9.0	4.5	22.5	6.3	35.9	52.2	64.7	9.0
Gesagard (1.0 L/fed)	30.6	29.4	17.1	32.2	78.7	27.8	35.1	62.9	17.1	32.2	78.7	27.8	35.1	62.9	141.6	17.1
Gesagard (0.75 L/fed)+ one hoeing	10.8	16.2	14.4	7.2	37.8	9.9	21.3	31.2	14.4	7.2	37.8	9.9	21.3	31.2	69.0	14.4
Hand hoeing (twice)	10.8	9.0	14.4	27.0	50.4	9.0	47.7	56.7	14.4	27.0	50.4	9.0	47.7	56.7	107.1	14.4
Un-weeded check	86.6	314.0	190.9	272.8	777.7	74.7	56.1	130.8	190.9	272.8	777.7	74.7	56.1	130.8	908.5	190.9
L S D. at 5%	3.1	7.6	3.3	2.8	5.3	4.0	NS	3.6	3.3	2.8	5.3	4.0	NS	3.6	8.9	3.3

Table 6. Effect of weed control treatments on Potato growth characteristics andyield (combined analysis in 2013/2014 and 2014/2015 seasons).

Tuber characteristics Weed control treatments	Tuber diameter (cm)	Number of tubers/ plant	Tuber weight (g)	Tuber yield (g / plant)	Yield grade A %	Specific gravity	T S S %	Tuber yield (ton / fed)
Sencor (0.3kg/fed)	4.8	10.2	56.3	574.0	75.8	4.29	7.0	11.82
Sencor(0.2 kg/fed)+ one hoeing	4.8	10.1	62.4	630.0	73.3	4.24	6.9	13.29
Gesagard (1.0 L/fed)	4.7	10.1	55.8	571.3	73.9	4.21	7.0	11.78
Gesagard (0.75 L/fed) + one hoeing	4.6	10.0	60.3	622.7	73.2	4.20	6.8	13.19
Hand hoeing (twice)	4.9	10.3	57.4	590.8	76.5	4.27	6.8	12.35
Un-weeded check	4.5	4.9	49.1	240.4	37.4	4.24	7.0	7.76
L S D. at 5%	NS	1.4	4.9	52.4	5.4	NS	NS	1.08

On NPK uptake in tuber yield:

Data in Table 7 and Fig. 1 indicated that treated potato plants by the herbicides and hand hoeing increased uptake NPK elements more than untreated plants. That, may be due to the herbicides used and hand hoeing gave highly effective on depressing weeds species as mentioned before which permit a more available NPK elements uptake to treated plants compared to untreated. So, all weed control treatments exhibited increases in potato yield (ton/fed) accompanied with significant increases in uptake of the three elements nutrients namely, nitrogen, phosphors and potassium. Sencor + hoeing, Gesagard + hoeing and hand hoeing twice treatments increased potato yield/fed by 71.2, 70.0 and 59.1%, nitrogen uptake kg /fed by 89.0, 83.4 and 73.2%, phosphorus uptake kg /fed by 156.0, 130.2 and 160.6%, and potassium uptake kg /fed by 67.9, 67.0 and 71.2%, respectively, than un-weeded treatment. Similar results were obtained by Bainade and Patel (1991).

Effect of the interaction between fertilization and weed control treatments:

On weeds and NPK uptake content:

All interaction effects between fertilization and weed control treatments on number and dry weight of weed species and NPK uptake by potato tubers under combined analysis were not significant at 5% level.

On yield and quality of potato tubers:

Data in Table 8 indicated that the effect of interactions between fertilizations and weed control treatments on number of tubers/plants, tuber yield (g/plant) tuber yield grade A% and tuber yield/fed were significant at 5% level.

Table 7. Effect of weed control treatments on NPK uptake (kg/fed) in potato tubers (combined analysis in 2013/2014 and 2014/2015 seasons).

Weed control treatments	N%	P%	K%	NPK uptake (kg/fed) N	P	K
Sencor (0.3 kg/fed) .	1.19	0.18	1.78	140.7	21.3	210.4
Sencor (0.2 kg/ fed)+one hoeing	1.28	0.21	1.75	164.8	27.9	223.6
Gesagard (1.0 L/fed)	1.15	0.16	1.72	135.5	18.9	199.1
Gesagard(0.75L/fed) + one hoeing	1.21	0.19	1.69	159.6	25.1	223.0
Hand hoeing (twice)	1.22	0.23	1.81	150.7	28.4	228.6
Un-weeded check	1.02	0.14	1.22	87.0	10.9	133.5
L.S.D at 5%	0.10	0.05	0.16	12.7	1.65	14.5

Concerning the number of tubers/plant, results showed that the highest number of tubers per plant was obtained by addition from interactions between farmyard manure at 20 m^3 + [100kg N, 30 kg P and 45kg K /fed] + bio-fertilizer with Gesagard at 0.75 l/fed plus hand hoeing once by 178%, following by hand hoeing twice by 151% or Sencor at 0.2 kg/fed plus hand hoeing once by 149% as compared with applying

the recommended mineral fertilizer and un-weeded check. The highest tuber yield grade A%, was achieved by the application of Sencor at 0.2 kg/fed + hand hoeing once with applying farmyard manure at 30 m^3 /fed + 50 kg N, 15 kg P and 22.5 kg K /fed + bio-fertilizer combination (91.8 %), following by interactions between Gesagard at 0.75 l/fed + hand hoeing once with farmyard manure at 30 m3/fed (50 kg N, 15 kg P and 22.5 kg K /fed + bio-fertilizer by 87.8 %.

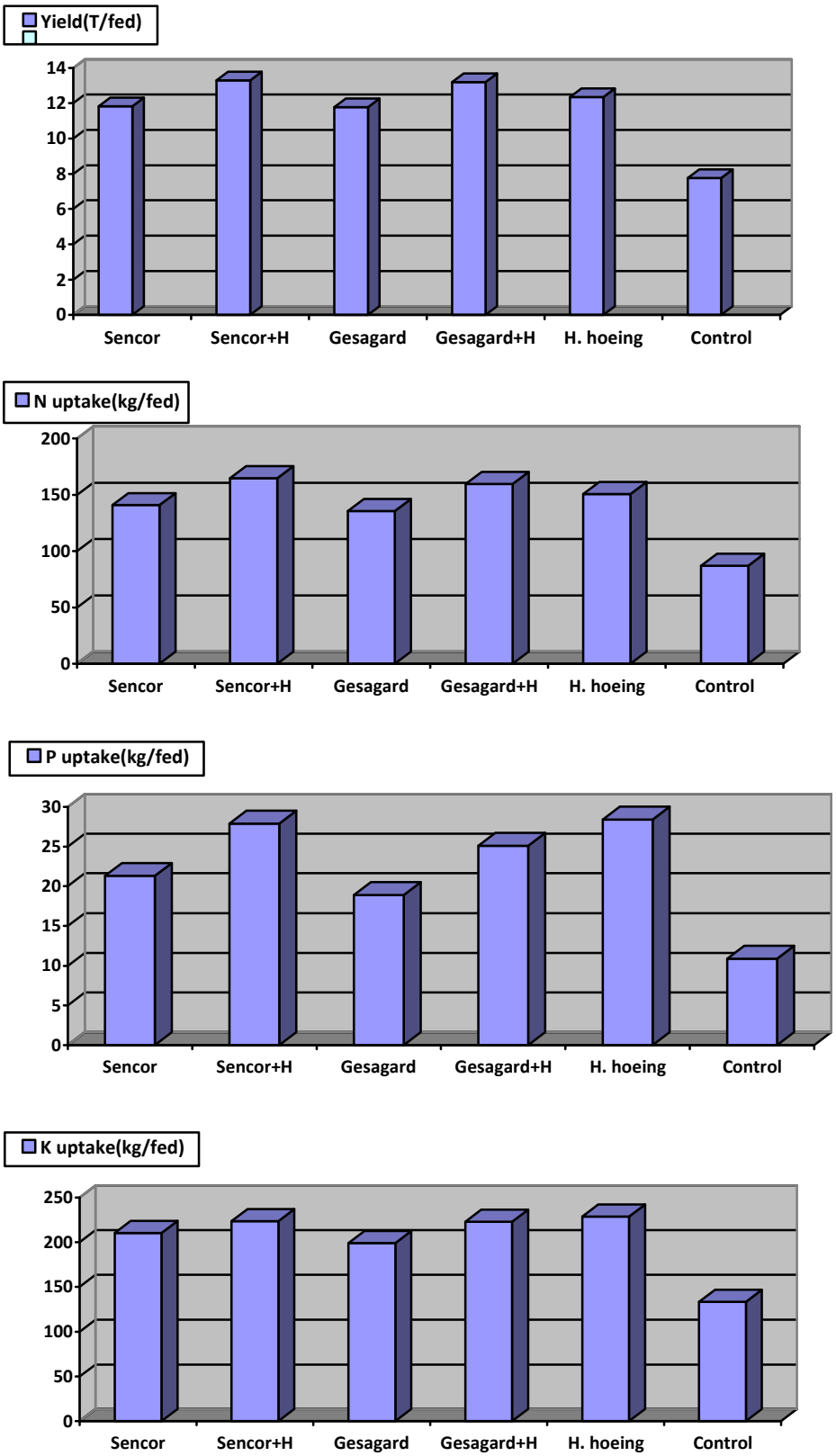

Fig. 1 Effect of weed control treatments on potato tuber yield (t/fed) and NPK uptake (kg/fed) in potato tubers (combined analysis in 2013/2014 and 2014/2015 seasons).

Regarding the tuber yield /plant and tuber yield/fed, data in Table 8 show that the greatest tuber yield was produced under the conditions of the complementary effect of fertilization by farmyard manure at 20 m^3 + NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer with Sencor at 0.2 kg/fed + hand hoeing once followed by Gesagard at 0.75 l/fed + hand hoeing once, and hand hoeing twice (802.8, 798.9 and 790.2 g/plant) for tuber yield /plant, and (17.99, 16.19 and 16.07 ton/fed) for tuber /fed, respectively. while the lowest tuber yield/plant and tuber yield /fed was recorded under NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer under un-weeded treatment (203.2 g/plant and 4.37 ton/fed), respectively.

Table 8. Potato tuber yield characters as affected by the interaction between fertilization and weed control treatments (combined analysis in 2013/2014 and 2014/2015 seasons).

Treatments	Sencor 0.3 kg/fed	Sencor 0.2 kg/fed + One hoeing	Gesagard 1.0 L/fed	Gesagard 0.75 L/fed + One hoeing	Hand Hoeing twice	Un-weeded cheek	Sencor 0.3 kg/fed	Sencor 0.2 kg/fed + One hoeing	Gesagard 1.0 L/fed	Gesagard 0.75 L/fed + One hoeing	Hand Hoeing twice	Un-weeded cheek
Fertilization treatments	Number of tubers/ plant						Tuber yield grade A(%)					
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	8.9	9.7	8.6	9.2	11.5	4.3	71.2	81.5	70.3	79.6	62.8	36.5
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	10.5	9.7	10.2	9.1	10.7	6.0	68.6	91.8	66.8	87.8	78.9	39.4
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	12.2	12.3	11.4	12.1	10.7	4.0	83.5	74.2	80.9	73.2	87.6	40.3
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	14.4	12.0	14.1	11.8	9.0	7.9	70.1	82.8	69.3	80.4	85.4	39.2
NPK [150 kg N, 45 kg P and 67.5kg K/fed] + bio-fertilizer	9.9	8.4	9.6	8.2	6.5	4.0	74.2	61.2	71.7	60.0	71.9	35.3
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	8.0	8.3	7.8	8.0	12.5	3.0	56.9	60.1	63.5	56.3	72.3	32.6
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	10.0	10.0	9.7	9.9	11.5	6.0	79.8	84.1	77.5	81.5	72.0	38.8
L S D at 5%			3.8						14.3			
	Tuber yield (g/ plant)						Tuber yield (ton/fed)					
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed]	537.4	623.6	532.4	621.2	546.3	239.8	10.27	11.40	10.07	11.13	11.08	5.46
Farmyard manure at (30 m3) + [50 kg N, 15 kg P and 22.5 kg K/fed] + bio-fertilizer.	595.4	769.2	589.8	762.8	672.0	281.2	14.26	15.13	14.18	15.03	13.88	5.42
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed]	741.4	772.9	738.9	783.9	715.8	223.0	15.64	15.78	15.26	15.46	16.01	5.46
Farmyard manure at (20 m3) + [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer.	748.0	802.8	746.3	798.9	790.2	242.2	16.01	16.08	15.94	17.99	16.19	6.99
NPK [150 kg N, 45 kg P and 67.5kg K/fed] + bio-fertilizer	448.5	458.5	444.6	453.6	465.6	203.2	7.51	9.93	7.34	9.68	9.82	6.16
NPK [100 kg N, 30 kg P and 45 kg K/fed] + bio-fertilizer	394.6	389.2	391.2	386.1	392.4	257.7	7.92	12.73	7.81	12.57	8.79	4.37
(Control) NPK [200 kg N, 60 kg P and 90 kg K/fed]	553.0	575.6	550.3	571.7	557.3	233.1	10.08		9.88		11.68	6.46
L S D at 5%			139.5						2.82			

Herbicides residues:

Results from Table 9 and Fig. 2 show that there was no any detectable residues existed from Gesagard and Sencor herbicides rates application in potato tubers at harvest. Pankova, (2001) found that levels of residues from Sencor in the edible parts of potato tubers were below level which could be determined by Gas Liquid chromatography as compared with chromatograms of the standards of such herbicides and below the MRL of them. Arora *et al.* (2009) found that no resides of prometryn (1.0 kg/ha), and Sencor (0.5 kg/ha) herbicides were detected which were applied in potato tubers as a result of applying it in potatoes/fed. .

Table 9. Residues for Gesagard and Sencor in potato tubers.

Herbicides	Rate / fad.	Residual ppm	Maximum residue level (MRL) ppm
Gesagard	1.0 L	*Not detected (ND)	0.5
Sencor	300 g	Not detected (ND)	0.1

*** Not detected: Below detection limit 0.01ppm of Gesagard and Sencor herbicides.**

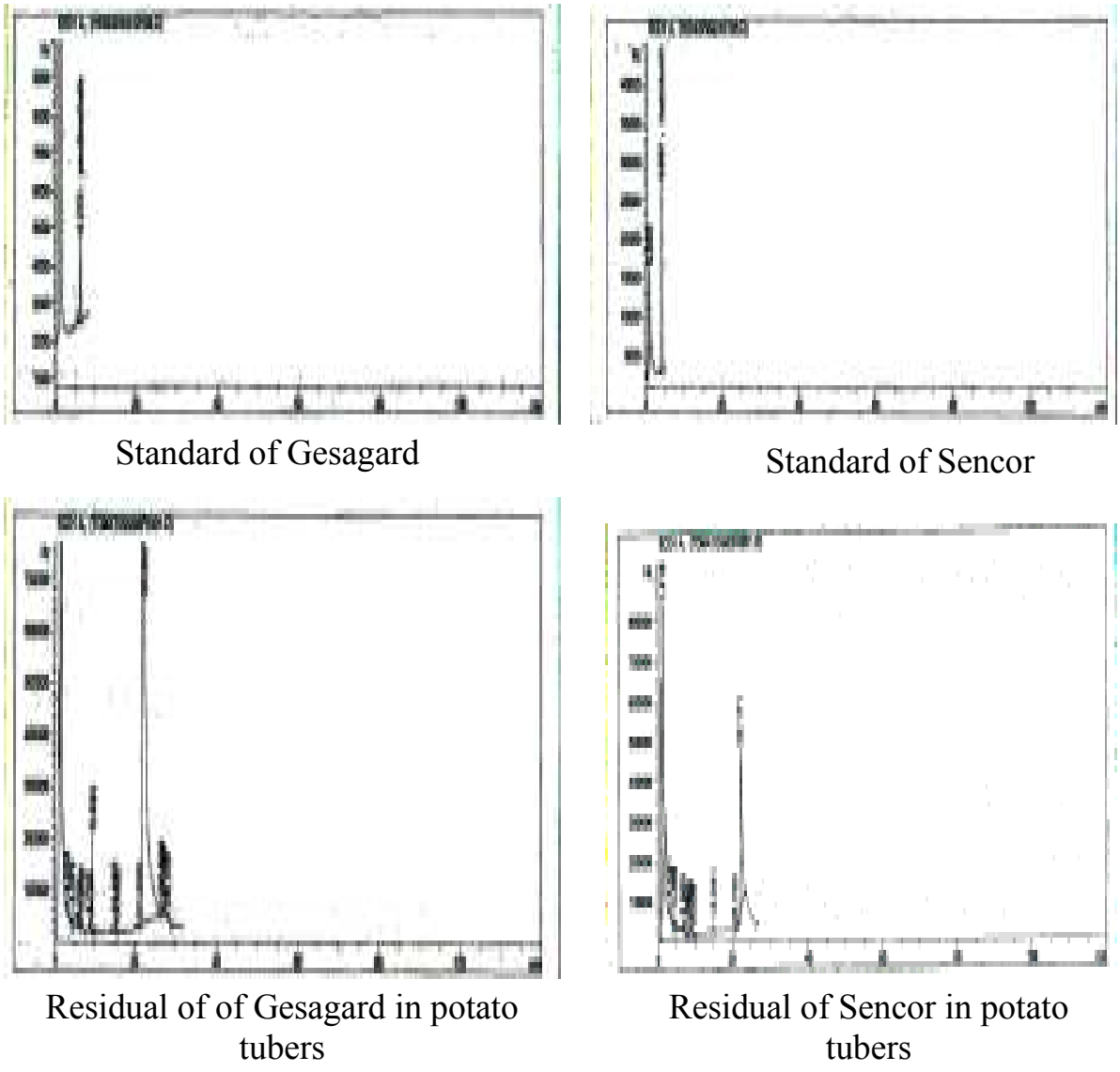

Fig. 2. Chromatograms of standard of Gesagard and Sencor in samples of potato tubers .

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تأثير التسميد العضوي والمعدني والحيوي ومكافحة الحشائش على أنواع الحشائش ومتبقيات المبيدات وامتصاص العناصر الكبرى لدرنات البطاطس وإنتاجيتها

ابراهيم السيد سليمان ، سعيد ضاحى محمد عيد و على على حسن شرشر

المعمل المركزي لبحوث الحشائش - مركز البحوث الزراعية - الجيزة - مصر

أجريت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا- كفرالشيخ خلال موسمي الزراعة ٢٠١٣/ ٢٠١٤ و ٢٠١٤/٢٠١٥ بهدف دراسة تأثير توليفات مختلفة من السماد العضوي والمعدني في وجود سماد حيوي مع استخدام بعض معاملات مكافحة الحشائش علي محصول البطاطس و الحشائش المصاحبة له وذلك في تصميم القطع المنشقة مرة واحدة في أربعة مكررات. اشتملت القطع الرئيسية على ستة توليفات مختلفة من السماد العضوي والمعدني في وجود السماد الحيوي مقارنة بالمعاملة القياسية من التسميد المعدني بالعناصر الثلاث الكبرى والقطع الشقية على ستة معاملات لمكافحة الحشائش هى جيساجارد معدل ١.٠ لتر/فدان ، سنكور معدل ٠.٣كجم/فدان، (جيساجارد معدل ٠.٧٥ لتر/فدان، سنكور معدل ٠.٢كجم/فدان) متبوعة بعزقة واحدة ، عزيق مرتين ومعاملة الكنترول. و تشير أهم النتائج إلي : - أدي استخدام توليفة التسميد العضوي والمعدني [٣٠متر٣ من السماد العضوي و٥٠كجم من النيتروجين و١٥ كجم من الفوسفور و٢٢.٥كجم من البوتاسيوم (سماد معدني/فدان)] إلي حدوث زيادة في الأعداد و الأوزان الجافة للحشائش مقارنة بمعاملات التسميد الاخري ومن ناحية أخرى زيادة في إنتاجية محصول البطاطس عن التسميد المعدني فقط. - أظهرت معاملات مكافحة الحشائش باستخدام مبيد (سنكور معدل ٠.٢ كجم/فدان أو جيساجارد معدل ٠.٧٥ لتر/فدان) + عزقة يدوية واحدة ، اعلي كفاءة لمكافحة الحشائش وزيادة محصول درنات البطاطس للفدان بمقدار ٤١.٦١، ٤١.١٧ و٣٧.٠% على التوالى. - أدي استخدام توليفة من التسميد المتكامل بإضافة [٢٠متر٣ من السماد العضوي مع ١٠٠كجم من النيتروجين و٣٠ كجم من الفوسفور و٤٥ كجم من البوتاسيوم (سماد معدني/فدان)] في وجود السماد الحيوي إلي الحصول علي اعلي عدد درنات / النبات و وزن الدرنة و المحصول الكلي للدرنات بالفدان بنسبة تفوق ٦.٣ ، ٢٦.٣ ، ٤١.٧ % على التوالي مقارنة بمعاملة الكنترول (٢٠٠كجم من النيتروجين و٦٠ كجم من الفوسفور و٩٠ كجم من البوتاسيوم /فدان). أيضا أظهرت نفس المعاملة أعلى قيم لمحتوى درنات البطاطس من النيتروجين والفوسفور والبوتاسيوم تحت معاملات مكافحة الحشائش المختلفة. - أدى التفاعل بين معاملة التسميد [٢٠متر٣ من السماد العضوي مع ١٠٠كجم من النيتروجين و٣٠ كجم من الفوسفور و٤٥ كجم من البوتاسيوم (سماد معدني/فدان)] في وجود السماد الحيوي مع مبيد الحشائش (سنكور معدل ٠.٢ كجم/فدان أو جيساجارد معدل ٠.٧٥ لتر/فدان) + إجراء عزقة يدوية واحدة ، إلي الحصول علي اعلي محصول لدرنات البطاطس وأعلى زيادة في امتصاص العناصر الكبرى من النيتروجين والفوسفور والبوتاسيوم. - تبين من تحليل متبقيات المبيدات تحت الدراسة في درنات البطاطس أن مبيد (سنكور بمعدل ٠.٣كجم /فدان) ومبيد (جيساجارد بمعدل ١.٠ لتر/فدان) لم يكن لهما أي آثار متبقية في درنات البطاطس. - توصى هده الدراسة مزارعى البطاطس باستخدام السماد العضوي كبديل لنصف معدل التسميد المعدني بمعدل ٢٠متر٣ /فدان والسماد المعدني معدل ١٠٠كجم من النيتروجين و٣٠ كجم من الفوسفور و٤٥ كجم من البوتاسيوم /فدان في وجود السماد الحيوي مع استخدام مبيد (سنكور معدل ٠.٢ كجم/فدان أو جيساجارد معدل ٠.٧٥ لتر/فدان) متبوعا بإجراء عزقة يدوية واحدة بعد ٤٥ يوم من الزراعة للحصول علي أفضل مكافحة للحشائش وأعلي إنتاجية وجودة لمحصول البطاطس كبديل للمكافحة اليدوية أو التسميد المعدنى فقط وخاصة انه لايوجد أي متبقيات للمبيدات المستخدمة في درنات البطاطس عند الحصاد.