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EFFECT OF ORGANIC MANURES, BIO-FERTILIZER AND MULCHING ON GROWTH AND YIELD OF POTATO (*SOLANUM TUBEROSUM* L.)

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ABSTRACT
An experiment on potato cv. Kufri Bahar was conducted at vegetable research farm, CCS Haryana Agricultural University, Hisar during 2010-11 and 2011-12. A set of sixteen treatment combinations were taken in sub plots while mulching and non-mulching in main plots under split plot design. All treatments showed superiority over control for plant height except biofertilizer treatment. Plant growth attributes like stem per hill, stem and leaves dry weight found significantly higher with the vermicompost + biofertilizer treatment followed by other treatments. Application of vermicompost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB) recorded maximum total yield (312 q/ha) and marketable yield (302 q/ha) followed by vermicompost treatment (311 q/ha) and (300 q/ha), respectively. It can be summarized that use of bio-fertilizer along with mulching proved useful in increasing growth and yield attributes and of potato crop significantly compared to control.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a member of solanaceae family and considered as one of the most valuable and widely distributed crops that is used for human food in most part of the world. It yields exceptionally high, produces more energy that is edible and protein per unit area and time than many crops. This also fits well in multiple cropping systems prevalent under tropical and subtropical agro-climatic conditions.

It has been realized that indiscriminate use of chemical fertilizers has affected the soil quality adversely in terms of decreasing organic carbon contents and development of micronutrients deficiencies and ultimately culminating into deterioration of produce quality (Naik and Khurana, 2003). This necessitates the immediate attention of researchers to evolve nutrient management strategies solving the problems of crop quality as well as soil conditions in holistic manner. Organic matters in soil influences almost all components of soil linked with crop production (Bhatt *et al.*, 2012). Organic farming has potential for reducing some of the negative impacts of conventional agriculture to the environment and an option to restore the productivity degraded soils (Ghosh *et al.*, 1998). The micronutrient can be supplied through various organic manures for averting the deficiencies thus favouring proper growth and development of crops. Kumar *et al.* (2005) reported prolonged effect of organic manures on fertility and soil moisture. It also reduce the chemicals needed for pest control, besides improve soil physical properties in long run. Biofertilizers play a significant role in either synthesizing plant usable form of nutrients or increase the availability of nutrients already present in the soil. Application of P-solublizing bacteria would help in increasing the efficiency of available P in the soil by converting unavailable P into available form. Similarly, N fixing biofertilizers like Azotobactor take the potential to meet a successful availability of N requirement of potato (Giller and Cadisch, 1995). Inoculation of chilli seedling with bio-fertilizer recorded maximum growth and fruit yield (Khan and Parari, 2012) and cauliflower (Shree *et al.,* 2014). The mulching shows beneficial effects on moisture conservation, weed control, soil physico-chemical and biological conditions in the dry season. Potato is reported to increase tuber yield when plants are mulched with plastics compared with plants grown in bare soil (Lamont, 2005; Ibarra-Jime nez, 2008). Colored plastic mulch also affects soil temperature and tuber production in potato (Ibarra-Jimenez *et al.,* 2011). Therefore, an experiment was carried out to examine the influence of mulching and different organic components on growth and yield attributes in potato.

MATERIAL AND METHODS

A field experiment on potato cv. Kufri Bahar was conducted at vegetable research farm, CCS Haryana Agricultural University, Hisar during 2010-11 and 2011-12. A set of sixteen treatment combinations as below:

T_1 : Control
T_2 : FYM 6.0 t/ha
T_3 : Vermicompost 6.0 t/ha
T_4 : Poultry manure 4.5 t/ha

T_5 : Bio-fertilizer (*Azotobacter* + PSB)

T_6 : FYM 3.0 t/ha + Vermicompost 3.0 t/ha

T_7 : FYM 3.0 t/ha + Poultry manure 2.5 t/ha

T_8 : FYM 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)

T_9 : Vermicompost 3.0 t/ha + poultry manure 2.25 t/ha

T_{10} : Vermicompost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)

T_{11} : Poultry manure 4.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)

T_{12} : FYM 6.0 t/ha + Vermicompost 2.0 t/ha + poultry manure 1.5 t/ha

T_{13} : Bio-fertilizer (*Azotobacter* + PSB)+ FYM 3.0 t/ha + Vermicompost 3.0 t/ha

T_{14} : FYM 3.0 t/ha + Poultry manure 2.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)

T_{15} : Vermicompost 3.0 t/ha + poultry manure 2.25 t/ha + Bio-fertilizer (*Azotobacter* + PSB)

T_{16} : FYM 2.0 t/ ha + Vermicompost 2.0 t/ha + poultry manure 2.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB) were taken in sub plots while mulching and non-mulching in main plots under split plot desing with three replications. The potato cv. Kufri Bahar with optimum seed size (35-40 g) was placed on each marked row at spacing of 60 x 20 cm. The weighed quantity of organic manures as per treatment was dressed on both sides of the row about 4-5 cm away. Thereafter, the soil from both sides was placed on tubers in such a way that it made a uniform size ridge of about 15-20 cm high. Pre-emergence irrigation was given twice during both the years of experimentation. The haulm was killed at 100 days after planting and harvesting of crop was done manually after 15 days of haulm killing. The plant growth (plant height, stem dry weight, stem/ hill, leaves dry weight/ hill and leaves/ stem) attributes were recorded on five randomly selected plants in each treatment and replication. The tubers were harvested in month of February in both of season and graded in four grades *viz.*, up to 25 g, 26-50g, 51-75 g and > 75g tubers and total and marketable yield was calculated. Statistical analysis was done using techniques of analysis of variance (ANOVA) as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant growth parameters

Analysis of variance suggests that all the parameters assessed were significantly affected by the treatments under study. The results revealed that significantly highest plant height (64 cm) was recorded under the mulching treatment compared to non-mulching (58 cm) treatment (Table 1). This treatment gave significantly higher number of stem per hill, stem and leaves dry weight per hill over non mulching treatment. However, there was non significant difference in number of leaves per stem under both treatments. This might be due to the mulching effect that helps in retaining soil moisture and suppress the growth of weeds which is helpful for the potato plant to take more nutrients and water from soil and minimize the risk of stress conditions.

All the manurial and bio-fertilizer treatment significantly

Table 1: Potato growth as infleudnced by different manures, bio-fertilizers and mulching treatments (pooled data of two years)

Treatments	Plant height (cm)	Stem dry weight per hill (g)	Stem per hill	Leaves dry weight per hill (g)	Leaves per stem
Mulching	64	57	3.39	153	11.24
Non-mulch	58	55	3.30	148	11.03
CD (P=0.05)	0.29	0.51	0.06	1.12	0.29
Control	57	51	3.15	138	10.20
FYM 6.0 t/ha	61	54	3.18	147	10.80
Vermi-compost 6.0 t/ha	62	58	3.55	157	11.60
Poultry manure 4.5 t/ha	62	55	3.28	149	11.00
Bio-fertilizer (*Azotobacter* + PSB)	59	52	3.30	141	10.30
FYM 3.0 t/ha + Vermi-compost 3.0 t/ha	61	56	3.40	152	11.20
FYM 3.0 t/ha + Poultry manure 2.5 t/ha	61	55	3.25	150	11.10
FYM 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	62	54	3.36	147	10.90
Vermi-comost 3.0 t/ha + poultry manure 2.25 t/ha	60	56	3.44	153	11.30
Vermi-compost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	64	59	3.60	160	11.80
Poultry manure 4.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	62	55	3.39	149	11.00
FYM 6.0 t/ha + Vermi-comost 2.0 t/ha + poultry manure 1.5 t/ha	61	57	3.35	155	11.40
Bio-fertilizer (*Azotobacter* + PSB)+ FYM 3.0 t/ha + Vermi-compost 3.0 t/ha	62	56	3.31	153	11.30
FYM 3.0 t/ha + Poultry manure 2.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	61	56	3.33	151	11.20
Vermi-comost 3.0 t/ha + poultry manure 2.25 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	60	57	3.27	155	11.50
FYM 2.0 t/ha+Vermi-compost 2.0 t/ha + poultry manure 2.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	60	58	3.40	157	11.60
CD (P=0.05)	2.32	1.42	0.16	1.58	NS

Table 2: Potato yield as influednced by different manures, bio-fertilizers and mulching treatments (pooled data of two years)

Treatments	Grade wise yield of potato tubers(q/ha)				Total yield (q/ha)	Marketable yield (q/ha)
	Up to 25g	26-50g	51-75g	>75g		
Mulching	74.65	86.76	98.22	37.37	297	276
Non-mulch	82.95	82.55	92.93	35.56	294	273
CD (P=0.05)	0.01	0.01	0.01	0.01	0.05	1.81
Control	71.80	72.43	80.80	32.98	258	238
FYM 6.0 t/ha	84.40	83.99	94.23	36.38	299	276
Vermi-compost 6.0 t/ha	87.30	86.15	100.34	37.21	311	300
Poultry manure 4.5 t/ha	83.47	81.99	92.43	36.11	294	272
Bio-fertilizer (*Azotobacter* + PSB)	74.20	73.93	82.88	31.99	263	245
FYM 3.0 t/ha + Vermi-compost 3.0 t/ha	85.49	86.21	95.31	37.99	305	284
FYM 3.0 t/ha + Poultry manure 2.5 t/ha	81.55	82.32	91.75	36.38	292	267
FYM 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	83.81	83.81	92.93	38.45	299	273
Vermi-comost 3.0 t/ha + poultry manure 2.25 t/ha	84.15	83.84	95.13	38.87	302	283
Vermi-compost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	88.69	88.64	101.15	33.53	312	302
Poultry manure 4.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	83.67	83.35	94.11	33.88	295	274
FYM 6.0 t/ha + Vermi-comost 2.0 t/ha + poultry manure 1.5 t/ha	83.17	84.94	95.67	36.22	300	274
Bio-fertilizer (*Azotobacter* + PSB)+ FYM 3.0 t/ha + Vermi-compost 3.0 t/ha	85.16	85.94	97.54	37.36	306	275
FYM 3.0 t/ha + Poultry manure 2.5 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	82.38	82.07	93.02	35.53	293	272
Vermi-comost 3.0 t/ha + poultry manure 2.25 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	86.10	85.51	97.20	35.19	304	280
FYM 2.0 t/ha+Vermi-compost 2.0 t/ha + poultry manure 2.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB)	85.63	84.23	96.28	35.87	302	279
CD (P=0.05)	0.08	0.08	0.08	0.09	0.34	5.19

increased plant height over control treatment except the bio-fertilizer treatment. The maximum plant height (64 cm) was recorded with vermi-compost + bio-fertilizer treatments while the least (57 cm) with control. All treatments showed superiority over control for plant height except bio-fertilizer treatment. Plant growth attributes like stem per hill, stem and leaves dry weight found significantly higher with the vermi-compost + bio-fertilizer treatment followed by other treatments. However, application of bio-fertilizer alone did not give significant higher number of stems per hill and stem dry weight. All treatments showed superiority over control for leaves dry weight but there was non significant difference for leaves per stem. Hussein *et al*. (2002a) reported that chicken manure and compost + bio-fertilizers increased stems per hill. Raghav and Kamal (2009) reported that the vegetative growth of plants in terms of number of haulms were maximum in treatment having combination of farmyard manure, poultry manure, vermi-compost along with bio-fertilizers.

Total and marketable yield

The pooled data of over two years presented in table 2 clearly indicate that different treatments influenced the grade of tubers as well as total and marketable yield of potato. The mulching treatment recorded significantly higher yields of all grade tubers except less than 26 g tubers compared to non-mulching treatment. The higher total yield (297 q/ha) and marketable yield (276 q/ha) were obtained with mulching treatment compared to (294 q/ha) and (273 q/ha), respectively in non-mulching treatment. All the manurial treatments produced significantly higher yield of all four grades tubers over control. However, bio-fertilizer treatment gave significanlty less yield of larger grade tubers (31.99 q/ha) compared to control (32.98 q/ha). Though total yield and marketable yield was significantly increased by all manurial treatments over control but maximum yield increase was given by Vermi-compost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB). This might be due to the better growth of plant and tuber under mulching, manure and bio-fertilizer treatments produced large size tuber than control. Verma *et al.,* (2010) reported that the treatment (Crop residues +Azotobacter+75% recommended dose of NPK) was found best among all treatments and gave highest number of tubers/ha, total tuber yield/ha. The tuber bulking rate, large and medium sized tubers and total tuber yield were obtained maximum from combinations of both bio-fertilizers and growth regulators reported by Ghosh and Das (1998). Similar effect of bio-fertilizers and vermi-compost on total tuber yield (q/ha) was reported by Kumar *et al*. (2013) and Kuang (2008) where the number of tubers per plant and yield were much greater in as compare to control.

Based on findings of experiment, it may be concluded that potato crop receiving Vermi-compost 6.0 t/ha + Bio-fertilizer (*Azotobacter* + PSB) recorded maximum total yield (312 q/ha) and marketable yield (302 q/ha) followed by vermi-compost treatment (311 q/ha) and (300 q/ha), respectively. Mulching was found useful in increasing yield of potato crop significanlty compared to non-mulching.

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