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Effect of Integrated Nutrient Management on Tuber Dry Matter Accumulation and Uptake of Nutrients by Potato (Solanum Tuberosum L.)

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Abstract- Potatoes have received a reputation as being a large consumer of nutrients such as nitrogen (N), phosphorus (P) and potassium (K). An experiment was conducted to study the effect of integrated nutrient management on the dry matter accumulation and uptake of nutrients in potato (*Solanum tuberosum* L.). Application of 50% RDF + 50% FYM + Azotobacter + Phosphobacteria (T_7) recorded maximum total dry matter production (21.67%) which was on per with T_3 (20.53%) and followed by T_4 (19.79%), T_5 (19.19%), T_9 (18.55%) and T_6 (18.42) during *rabi* 2011. Similarly the maximum uptake of N (97.17 kg/ha), P (21.76 kg/ha) and K (159.63 kg/ha) was found with plants provided with 50%RDF + 50%FYM + Azotobacter + PSB (T_7) which was on par with T_4, T_3 and T_5 during *rabi* 2011. The minimum dry matter accumulation (15.32%) and N (83.40 kg/ha), P (16.13 kg/ha) and K (108.23 kg/ha) was registered with 100%FYM + 50% N supplied through neem cake + Azotobacter (T_8).

Keywords: potato, azotobacter, phosphobacteria, dry matter production, nutrient uptake, NPK concentration and vermicompost.

I. Introduction

Potato (*Solanum tuberosum* L.) constitutes staple food in many countries worldwide. It possesses inbuilt genetic potential to yield huge biomass in short time/unit land. In India, farmers have been regularly growing this crop even under acute price fluctuation and shortage of cold storage facilities. Potato allows the farmer to harvest up to 80% of dry matter as edible nutritious food, as compared to only 50% of the cereals as grain (Pandey *et al*., 2005). Besides being nutritionally superior and highly productive than most food crops, it has a relatively short duration and therefore amenable for inclusion in the intensive cropping system. Continuous use of inorganic fertilizers cause detrimental effects on soil physical health and thus reduces crop yields drastically (Guar 2002). A promising method to counteract these emerging threats is to switch on to organic farming practices which involves use of organic manures like FYM, vermicompost, poultry manure, neem cake, etc. and biofertilizers like *Azotobacter* and Phosphobacteria. Numerous works have been done on the integrated use of nutrients on potato, however, information regarding use of strictly organic manure alone and its effect on dry matter accumulation and nutrients uptake by potato is still lacking. Assessment of dry matter accumulation, uptake of nutrients and its distribution to various parts of the plant is essential for understanding the nutrient requirement also to estimate the nutrient removal by the crop. Accumulation and uptake of nutrients in a plant depends on many factors such as physico-chemical characteristics of soil, cultivar and agro-climatic situation. Therefore, a field experiment was conducted in Eastern Dry Zone of Karnataka to know the effect of integrated use of different organic and inorganic bio-fertilizer sources of nutrients on tuber dry matter accumulation and uptake of nutrient by potato variety Kufri jyoti.

II. Material and Methods

The field trail was carried out in sandy loam soil at Post Graduate Centre, University of Horticultural Sciences, Campus, Gandhi Krishi Vignana Kendra, Bangalore during *Rabi* 2011. There were 1o treatment combinations of organic, inorganic and biofertilizers *viz*., 100% recommended dose of fertiliser (125:100:125 kg NPK ha^{-1}) (T_1); 100% RDF + 100% FYM (25t ha^{-1}) ($T_{2)}$; Soil Test Crop Response targeted yield (155:150:129 kg NPK ha^{-1}) (T_3); 50% RDF + 100% FYM + Azotobacter (12 kg ha^{-1}) + Phosphobacteria (kg ha^{-1}) (T_4); 75% RDF + VC (1.5t ha^{-1}) + Azotobacter (12 kg ha^{-1})+ Phosphobacteria (12 kg ha^{-1}) (T_5); 50% RDF + Azotobacter (12 kg ha^{-1})+ Phosphobacteria (12 kg ha^{-1}) (T_6); 50% RDF + 50% FYM + VC (1.5t ha^{-1}) + Azotobacter (12 kg ha^{-1})+ Phosphobacteria (12 kg ha^{-1}) (T_7); 100% FYM + 50% Nitrogen supplied through neem cake (62.5 kg ha^{-1}) +Azotobacter (12 kg ha^{-1}) (T_8); 100% FYM + 50% nitrogen supplied through poultry manure (1.5t ha^{-1}) + Azotobacter (12 kg ha^{-1}) (T_9) and 100% FYM + 50 % FYM supplied through vermicompost (1.5 t ha^{-1}) + Azotobacter (12 kg ha^{-1}) (T_{10}). The experiment was laid out in RCBD and the treatments were replicated three times. The dry matter production was estimated on over dry weight basis on five randomly selected plants. Uptake of major nutrients

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and available NPK in the soil were also assessed. The content of nutrients was estimated by following standard procedures as outlined by Jackson (1973). The uptake of nutrients was calculated by multiplying their content with dry weight expressed as kg/ha.

III. Results and Discussion

Data pertaining to dry matter accumulation in different plant parts at harvest of potato differed significantly during *rabi* 2011 due to varying fertility levels (Table1). Application of 50% RDF + 50% FYM + Azotobacter + PSB (T_7) recorded significantly higher dry weight in shoot (50.7 g plant^{-1}), leaves (62.3 g plant^{-1}), roots (15.0 g plant^{-1}), tuber (127.3 g plant^{-1}) and total dry weight (255.3 g plant^{-1}) which was on par with the treatments T_3 and T_4.

Table 1: Effect of Integrated Nutrient Management on Dry Weight in Different Plant Parts at Harvest

Treatments	Dry weight (g/plant)				Total dry weight (g)
	Leaves	Shoots	Roots	Tubers	
T_1	31.7	24.3	10.7	86.3	153.0
T_2	34.0	27.7	11.3	95.3	168.3
T_3	51.0	46.0	14.3	121.7	233.0
T_4	51.3	44.0	14.0	118.3	227.6
T_5	43.0	32.3	13.3	111.3	199.9
T_6	40.3	31.0	12.7	104.0	188.0
T_7	62.3	50.7	15.0	127.3	255.3
T_8	24.7	22.3	9.7	83.3	140.0
T_9	36.7	29.3	12.0	101.0	179.0
T_{10}	27.0	25.3	11.0	92.3	155.6
SE m ±	1.88	2.16	0.73	5.17	6.54
CD at 5%	3.95	4.54	1.52	10.87	13.74
CV (%)	5.73	7.95	7.16	6.09	4.21

The increased dry weight could be attributed to better vegetative growth and also more of fresh weight. Increased dry weight is also related to better uptake of nutrients due to the influence chemical fertilizers (T_3). The better absorption and accumulation of nutrients promotes growth and metabolism. This in turn resulted in production of more dry weight accumulation. The growth attributes due to application of bio-fertilizer in conjunction with vermicompost (T_7) were enhanced by production of bio active substances having similar effects as that of growth regulators besides nitrogen fixation through bio-fertilizer leading to greater dry matter production. The higher dry matter production is attributed to the cumulative effect of progressive increase in growth attributes *viz*., plant height, number of stems per plant, stem girth and number of leaves per plant. Similar results were also reported by Kumar Manoj *et al.* (2011), Zaman *et al.* (2011), Sarkar et *al.* (2011) in potato, Ramanandam *et al.* (2008) in cassava (*Manihot esculenta* Crantz), Nedunchezhian and Srinivasulureddy (2002) in sweet potato.

Data pertaining to total nitrogen, phosphorus and potassium uptake as influenced by integrated nutrient management practices (Table 2). The plants provided with 50% RDF+ 50%FYM+AZT+PSB (T_7) recorded higher total nitrogen uptake (97.17 kg ha^{-1}) which was on par with T_3 (96.40 kg ha^{-1}), T_4 (95.20 kg ha^{-1}) and T_5 (94.47 kg ha^{-1}) during *rabi* 2011 respectively. This could be attributed to better availability of nutrients when plants received in combination of inorganic, organic and biofertilizers. It is also related to application of biofertilizers especially Azotobacter which helped in fixation of atmospheric nitrogen while the applied FYM improve the soil physical and chemical properties which aid in uptake of nitrogen. The increased uptake could be due to higher availability of nutrients and increased absorptive area, which resulted in higher tuber yield. Similar results were noticed by Parmar *et al.* (2007) in potato, Alfred Hartemink *et al.* (2000) in taro, Ramanandan *et al.* (2008) in cassava, Patil (1998) in chilli, Murukumar and Patil (1996) in capsicum.

Maximum total phosphorus uptake (21.76 kg ha^{-1}) during *rabi* 2011 was observed in the plants treated with 50% RDF+ 50%FYM+AZT+PSB (T_7) which was on par with T_3 (21.43 kg ha^{-1}) and T_4 (21.07 kg ha^{-1}) respectively. The maximum total phosphors uptake (21.767 kg ha^{-1}) was observed in plants fertilized with 50% RDF + 50% FYM + VC + AZT + PSB (T_7) and it was *on par* with the treatments of T_3 (21.43 kg ha^{-1}) and T_4 (21.07 kg ha^{-1}). This could be attributed to improved physical and chemical properties of soil due to applications of organic manures and biofertilizers especially phosophobateria which enhanced the inorganic phosphorus in available form. Increased phos-

phorous uptake is also due to solubilization of insoluble form of phosphors into soluble form by phosphobateria there by increased uptake of phosphorus (Olsen *et al.,* 1999). These results are in the line of Mahendran *et al*. (1996) who have reported that application of NPK fertilizers with bio-fertilizers viz., Azospirillum and phosphobacterium significantly influenced N and P content and uptake of NPK by different plant parts. This is in conformity with the findings of Nandekar *et al.* (1992) in potato crop.

Total potassium uptake was also highest (159.63 kg ha^{-1}) during *rabi* 2011 with application of 50% RDF + 50% FYM + Azotobacter + Phosphobacteria (T_7) which was on par with T_4 (153.90 kg ha^{-1}) (Table 3). This could be attributed to the pronounced improvement in soil fertility through the addition of FYM and the substitution of NPK nutrients supplied through Azotobacter and PSB facilitated effective utilization of available nutrients. Hoda Habib *et al.* (2011) reported that uptake of nutrients NPK may be due to the increase of enzymatic activities which affect on absorption of mineral nutrients by plant and in turn increase its concentration in plant parts. The results are in the conformity with the findings of Parmar *et al.* (2007), Singh *et al.* (1996) and Shambhavi and Sharma (2008a) in potato.

Table 3: Effect of Integrated Nutrient Management on Total Nitrogen, Phosphorus and Potassium Uptake by Potato

Treatments	Nitrogen Uptake (kg ha^{-1})	Phosphorus Uptake (kg ha^{-1})	Potassium Uptake (kg ha^{-1})
T_1	90.50	18.80	138.33
T_2	93.33	19.13	147.30
T_3	96.40	21.43	147.30
T_4	95.20	21.07	153.90
T_5	94.47	20.13	145.06
T_6	91.56	19.33	149.83
T_7	97.17	21.76	159.63
T_8	83.40	16.13	108.23
T_9	93.10	19.97	144.53
T_{10}	89.00	18.53	127.36
SE m ±	1.53	0.52	4.18
CD at 5%	3.22	1.09	8.79
CV (%)	2.03	3.26	3.64

It can be concluded that application of 50% RDF + 50% FYM + Azotobacter + Phosphobacteria (T_7) recorded highest dry weight of shoot (50.7 g plant^{-1}) during *rabi* 2011 which was followed by T_3 (46.0 g plant^{-1}), T_4 (44.0 g plant^{-1}) and T_6 (32.3 g plant^{-1}); highest dry weight of leaves (62.3 46.0 g plant^{-1}) which was on par with T_4 (51.3 46.0 g plant^{-1}) and T_3 (51.0 46.0 g plant^{-1}) respectively. Application of 75% RDF + 75% FYM + Azotobacter + Phosphobacteria (T_7) recorded higher root dry weight (15.0 46.0 g plant^{-1}) which was on par with T_3 (14.3 g plant^{-1}) and T_4 (14.0 g plant^{-1}) respectively, highest tuber dry weight (127.3 46.0 g plant^{-1}) which was on par with T_3 (121.7 g plant^{-1}) and T_4 (118.3 g plant^{-1}) and total dry weight (255.3g plant^{-1}). Similarly the maximum N uptake (97.17 kg ha^{-1}), P (21.76 kg ha^{-1}) and K (159.63 kg ha^{-1}) was found with the plants provided with 50% RDF + 50% FYM + Azotobacter + Phosphobacteria (T_7) which was on par with T_3 and T_4 during *rabi* 2011.

Table 2: Effect of Integrated Nutrient Management on Accumulation of Nitrogen, Phosphorus and Potassium in Different Plant Parts of Potato at Harvest

Treatments	Nitrogen Accumulation (%)			Phosphorus Accumulation (%)			Potassium Accumulation (%)		
	Stem	Leaf	Tuber	Stem	Leaf	Tuber	Stem	Leaf	Tuber
T_1	1.29	1.14	1.08	0.12	0.49	0.93	2.03	2.61	4.24
T_2	1.31	1.18	1.12	0.12	0.53	0.94	2.09	2.75	4.31
T_3	1.80	1.30	1.27	0.16	0.58	1.08	2.17	3.35	4.39
T_4	1.76	1.29	1.24	0.16	0.56	1.05	2.17	3.43	4.35
T_5	1.72	1.26	1.19	0.15	0.55	0.99	2.15	3.08	4.34
T_6	1.66	1.25	1.16	0.14	0.54	0.97	2.12	2.99	4.34
T_7	1.85	1.33	1.28	0.17	0.59	1.12	2.22	3.93	4.52
T_8	1.15	1.11	1.04	0.11	0.48	0.91	2.03	2.42	4.19
T_9	1.33	1.20	1.12	0.13	0.54	0.95	2.11	2.79	4.31
T_{10}	1.26	1.16	1.07	0.12	0.52	0.94	2.06	2.72	4.26
SE m ±	0.02	0.02	0.02	0.01	0.01	0.03	0.02	0.18	0.03
CD at 5%	0.04	0.04	0.04	0.02	0.02	0.06	0.04	0.39	0.06
CV (%)	4.67	1.65	1.64	6.40	3.06	3.26	1.43	7.31	0.99

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