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Effect of integrated nutrient management by solid and liquid fertilizers on yield attributes and yield of field pea (*Pisum sativum* L.) under irrigated conditions

HARPREET KAUR AND KAMALESH KUMAR*
General Shivdev Singh Diwan Gurbachan Singh Khalsa College, Patiala, 147001
Corresponding author: caukamlesh@gmail.com

Abstract

A field experiment was conducted at Campus for Research and Advanced Studies, Dhablan, P.G. Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala during Rabi *season 2020-2021. The experiment was conducted in split plot design and replicated thrice. The treatment in main plot consisted of three different levels of recommended dose of solid fertilizers and in sub plot five different concentrations of organic and inorganic liquid fertilizers. Soil of the experiment field was clayey in texture had soil pH 7.45 (slightly alkaline), medium organic carbon (0.71%), low in available nitrogen (264.64 kg ha^{-1}), medium in available phosphorous (21.6 kg ha^{-1}) and high in available potassium (282 kg ha^{-1}). A keen observation of data revealed that application of solid fertilizers and liquid fertilizers both organic and inorganic significantly influenced the yield attributes like number of pods plant^{-1}, number of seeds pod^{-1}, test weight (g), harvest index(%) and yield viz., grain yield, stover yield and biological yield (q ha^{-1})was significantly maximum at treatment SF_1 = 100 % recommended dose of fertilizer with foliar application at treatment LF_5 = 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution at 20, 40, 60 DAS and at par with application of 6% Panchgavya solution in LF_1.*

Keywords: *Pisum sativum* L., integrated nutrient management, yield.

Introduction

Pea (*Pisum sativum* L.) is an important *Rabi* pulse crop after lentil and chickpea in India. It is also known as "queen of pulses". Field pea are harvested in mature conditions, mature seed may be used as used as whole or split into 'dal' and prepared in various ways for human consumption.

Field pea (*Pisum sativum* L.) is an herbaceous pulse crop in the world which belong family *Leguminosae* or *Fabaceae*. Field pea is most common nutritious vegetable grown and consumed as either fresh, frozen, canned or in dehydrated form. It is highly nutritive and contains high amount of digestible protein 22.5 g, minerals, fat 1.8 g, carbohydrates 62.1 g, vitamins A and C, calcium 64 mg, phosphorous 139 mg and has high levels of amino acids lysine and tryptophan (Pandey *et al*. 2017).

The concept of integrated nutrient management involves the maintenance of soil fertility to an optimum level for crop productivity to obtain the maximum benefits from all possible sources of plant nutrients like organic manures, crop residues, biofertilizers and chemical fertilizers (Pandey *et al.* 2017). INM was an advanced approach that seeks to both increase quality of production as well as protect the environment for posterity.

Fertilizers play important role on growth and productivity of pea. Nitrogen has important role in seed protein and physiological functions of the plant and supports the plant with rapid growth, increasing seed and fruit production and enhancing quality of leaf and seed yield. The good supply of phosphorous is usually associated with increased root density, fruit

production and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant and potassium is for cold hardiness, disease resistance, drought resistance and tolerance and general durability.

Nutrients may be applied to the soil or they may be applied to the foliage of the plants. These solutions may be prepared in alow concentration to apply any one of plant nutrients or a combination of nutrients. Among the nutrients N is most frequently applied because absorption of N is more rapid. Foliar spray of 4 - 6% Urea solution, is common just before flowering or at flowering increases grain quality and leaf area duration. Foliar application of P and K is less frequent than N due to of low solubility. Vermiwash is a rich source of vitamins, hormones, soil enzymes, macronutrients applied to plants helps in resulting higher growth and yield and also improve physiochemical properties of soil and reduced the insect-pest infestation. Panchagavya, an organic product contains five ingredients evolving from cow (dung, urine, curd, ghee, and milk), jaggery, tender coconut water and bananas. It possesses bio-pesticidal properties, also potential to boosting and growth in plant system and also provide immunity to plant.

Materials and Methods

Experiment conducted during *Rabi* season of the year 2020-21 at the Campus for Research and Advanced studies, Dhablan, PG Department of Agriculture, G.S.S.D.G.S Khalsa College, Patiala.The experiment was laid out in Split Plot Design (SPD) with 15 treatments each treatment was replicated three times. It contains of 3 different solid fertilizer with different concentration and 5 different liquid fertilizer with different concentration.

Soil of the experiment field was clayey in texture had soil pH 7.45 (slightly alkaline), medium organic carbon (0.71%), low in available nitrogen (264.64 kg ha^{-1}), medium in available phosphorous (21.6 kg ha^{-1}) and high in available potassium (282 kg ha^{-1}). All solid fertilizers viz., nitrogen 20 kg ha^{-1}, phosphorous 60 kg ha^{-1} and potassium 30 kg ha^{-1} was applied at time of sowing. Nitrogen was applied in the form of urea, phosphorous was applied in the form of single super phosphate and potassium was applied in the form of murate of potash. Spray of Panchagavya solution, Vermiwash solution, Urea solution and DAP solution was done three times during the crop period at 20 DAS, 40 DAS and 60 DAS per treatment were sown on 10th October, 2020 and harvested at 10th March, 2021. The crop was sown in lines at spacing of 30cm × 10cm with the help of pora method. From each plot 5 plants were selected randomly and tagged for recording different observations at different growth stages. The data were recorded from each plot at monthly intervals i.e., 30, 60, 90 DAS and at harvesting. The samples for various parameters were collected from the plots.

Results and Discussion

Yield parameters

Among the important factors, integrated nutrient management is one which determines sustained plant growth, development and production of crop. A use of fertilizer dose 20 kg N ha^{-1} (through urea 46%), 60 kg P ha^{-1} (through single super phosphate 16% P_2O_5) and potash 30 kg ha^{-1}(through muriate of potash 60% K_2O) were applied one day before sowing and application of liquid fertilizers Panchgavya solution (5% and 3%), Vermiwash solution (5% and 3%), DAP solution (2 % and 1%) and 2% Urea solution was done three times during the crop period at 20 DAS, 40 DAS and 60 DAS is be one of most important factor to increase yield attributes and yield of crop (Table 1).

Number of pods plant^{-1}

It is the most important component for realizing yield of pea. Highest number of pods plant^{-1} (23.82) was recorded at 100% RDF levels and at par with 75% at harvest. Nitrogen and phosphorous had a significant on number of pods plant^{-1}. This is due to the optimum application of nitrogen and phosphorous increase number of pods plant^{-1} due to the improved flower formation, seed production and proper availability of fertilizer by which plant uptake more nutrition. Similar result was obtained by Qureshi *et al.* (2015), Pandey *et al.* (2017) and Dhiman M. (2016).

Number of pods plant^{-1} highest (25.78) with fertilization of 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS). Number of pods plant^{-1} is mainly increased by the plant hormones phosphorus availability; these solution gives available P to plant for making seeds in pod. Lowest number of pods

Table 1: Effect of integrated nutrient management by solid and liquid fertilizers on number of pods plant^{-1}, number of seeds pod^{-1}, test weight (g) and harvest index (%) of pea at harvest stage

Treatments	Yield attributes			
	No. of pods plant^{-1}	No. of seeds pod^{1}	Test weight (g)	Harvest index (%)
Solid fertilizer				
SF_1	23.82	8.47	137.60	47.47
SF_2	22.67	8.07	136.00	47.20
SF_3	21.08	7.20	133.60	45.47
SEm±	0.32	0.09	0.44	0.46
CD 5%	1.25	0.37	1.71	1.95
LiquidfertilizerLF_1	24.44	8.78	138.89	47.44
LF_2	21.50	7.56	134.22	46.78
LF_3	20.97	7.22	133.56	46.67
LF_4	19.92	7.00	130.89	44.22
LF_5	25.78	9.00	140.89	48.22
SEm±	0.61	0.14	0.85	0.46
CD 5 %	1.77	0.41	2.46	1.32

Note: LF_1: 5% Panchgavya solution
LF_2: 5% Vermiwash solution
LF_3: 2% Urea solution + 3% Vermiwash solution
LF_4: 2% DAP solution
LF_5: 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution
SF_1: 100% RDF
SF_2: 75% RDF
SF_3: 50% RDF

plant^{-1} (19.92) at 2% DAP solution. The result of the experiment study is in collaboration with the earlier reports of Dutta *et al.* (2018).The interaction of both solid and liquid fertilizer showed significant result in number of pods. The maximum number of pods plant^{-1} reported with 100% RDF levels in SF_1 and application of 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) in LF_5.

Number of seeds pod^{-1}

Highest number of seeds pod^{-1} (8.47) was observed at 100% RDF over other levels of RDF. This might be due to that number of seeds pod^{-1} increased by the optimum application of N and P they improve the seed formation since it is an important constituent of DNA and some enzymes. Similar result was found by Devi *et al.* (2018) and Metha *et al.* (2016).

Highest number of seeds pod^{-1} (9.00) were recorded at 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) by foliar application which show synergistic effect on number of seeds pod^{-1}. This might be due to the that better nutrition of crop and more will be the number of seeds pod^{-1}. The lowest (7.00) number of seeds pod^{-1} at fertilization of 2% DAP solution. These findings are in conformity with the previous findings of EI Sayed *et al.* (2012) and Dutta *et al.* (2018).The interaction of SF and LF showed significant increase in number of seeds pod^{-1}. Highest number of seeds pod^{-1} recorded in SF_1 and LF_5.

Test weight (g)

Both solid and liquid fertilizers affected the test weight of pea, Highest test weight (137.60) was obtained at high fertilizer levels viz. 100% RDF and at par with 75% RDF. This is due to the positive effect of nitrogen and phosphorous on the crop leads to promote leaf area development and maintain leaf area growth and better stored accumulates in seeds which increase the test weight. Same results were also reported by Qureshi *et al.* (2015) and Lalito *et al.* (2018).

Foliar fertilization of different concentration of organic and inorganic solution significantly affects the test weight. Highest test weight (140.89) found at 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution

(20, 60 and 90 DAS) and at par with 5% Panchgavya solution spray. This is might be due to the N and P and plant growth hormones which provides by Panchgavya, Vermiwash, Urea and DAP solution plays an important role in seed formation. Similar results were also found by EI Sayed *et al.* (2012). The interaction of solid fertilizer and liquid fertilizer showed significant results in test weight. The maximum test weight found in SF_1 and LF_5.

Harvest index (%)

Harvest index is defined the pounds of grain divided by the total pounds of above biomass (biological yield).Maximum harvest index recorded (47.47%) at 100% RDF and at par with 75% RDF. The minimum harvest index (45.47%) was found at 50% RDF. This is due to higher growth and yield contributing characters like plant height, number of leaves, fresh weight, number of branches, dry weight, pods plant^{-1}, seeds pod^{-1}, grain yield and test weight of plant. Harvest index increase with increasing grain yield by nitrogen and phosphorous high levels. Similar findings are reported by Rani *et al.* (2017).

Similarly, maximum harvest (48.22%) by the application of at 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) and at par with 5% Panchgavya solution spray. Application of 2% DAP solution gave minimum harvest index (44.22%).

Table 2: Effect of integrated nutrient management by solid and liquid fertilizers on grain yield (q ha^{-1}), stover yield (q ha^{-1}) and biological yield (q ha^{-1}) of pea

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})
Solid fertilizer			
SF_1	21.67	25.0046.64	
SF_2	20.87	22.4043.27	
SF_3	17.87	20.4738.30	
SEm±	0.35	0.530.57	
CD 5%	1.39	2.082.23	
Liquid fertilizerLF_1		23.0025.00	48.00
LF_2	20.22	20.7841.00	
LF_3	18.89	21.7840.65	
LF_4	15.11	20.0035.10	
LF_5	23.44	25.5649.00	
SEm±	0.37	0.630.36	
CD 5 %	1.08	1.821.04	

Maximum harvest index by increase in grain yield. The interaction of solid and liquid fertilizers showed significant results in harvest index. Maximum harvest index observed in SF_1 and LF_5.

Yield

Grain yield (q ha^{-1})

Yield characters are the one of the most important characters in a crop (Table 2). Grain yield is the economic part of the harvest, which shows the resultant effect of different treatments. Nitrogen and phosphorous application enhance the grain yield of pea with the application of 100% RDF produced higher grain yield than other levels. Highest grain yield (21.67 q ha^{-1}) was recorded at 100% RDF and at par with 50% RDF levels. The reason might be due to net crop assimilation rate and a greater number of grains. Similar result was found by Rani *et al*. (2017) and Sunday *et al.* (2018).

Liquid fertilizers had also a significant effect on the yield of the grain. Maximum grain yield (23.44 q ha^{-1}) recorded at 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) and at par with 5% Panchgavya solution spray. The minimum grain yield (23.00 q ha^{-1}) recorded at 2% DAP solution. The reason for that be due to increases the efficiency of the carbohydrates and photosynthetic rate. Similar results were found by Dutta *et al.* (2018).The interaction of SF and LF showed significant increase the grain yield. The highest grain yield recorded in SF_1 and LF_5.

Stover yield (q ha^{-1})

Stover yield, a measurement of vegetative growth after harvesting of crop.High levels of RDF increased the stover yield of pea crop. Significantly higher stover yield (25.00 q ha^{-1}) observed at 100% RDF applications. Higher stover yield with full dose of fertilizers because they increased dry matter production of pea through its favorable effect various parameters. The present findings are in line with Lalito *et al.* (2018) and Dhiman M. (2016).

Similarly maximum stover yield (25.56 q ha^{-1}) by the foliar fertilization of 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) and at par with 5% Panchgavya solution. The minimum stover yield (20.00 q ha^{-1}) with application of 2% DAP

solution. This is due to more will be the grain yield more will be the stover yield. The outcome of the present study agreed with previous findings of Dutta *et al.* (2018). The interaction of both solid and liquid fertilizer showed significant increase in stover yield. Maximum stover yield found in SF_1 and LF_5.

Biological yield (q ha^{-1})

Biological yield is the total yield of the crop. The biological yield increased with increasing in grain and straw yield. Significantly higher biological yield (46.64 q ha^{-1}) recorded with application of 100% RDF. Biological yield was increased may be due to the higher grain and stover yield. Same result also reported by Rani *et al.* (2017) and Qureshi *et al.* (2015).

By foliar application of 3% Panchgavya solution + 5% Vermiwash solution + 2% Urea solution + 1% DAP solution (20, 60 and 90 DAS) provides maximum biological yield (49.00 q ha^{-1}) and at par with 5% Panchgavya solution. The reason for increasing biological yield is better crop growth rate and higher grain and stover yield enhance biological yield. The interaction of both fertilizer solid and liquid showed significant results on biological yield. The highest biological yield is recorded in SF_1 and LF_5.

All the yield contributing characteristics like number of pods and seeds, test weight, harvest index, grain, stover and biological yield showed the significant differences due to different treatments. This might be due to integration of organic and inorganic sources of nutrients enhanced the yield attributes, nodulation of crop and in turn produced more pod yield (Gopinath and Mina, 2011).

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