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Original Paper

The Influence of Plastic Mulching Materials and Sowing Dates on the Yield and Yield Components of Pea (*Pisum sativum L.*)

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Abstract

The use of plastic mulches affects the microclimate in the vicinity of the plant by modifying the radiation on the soil surface and reduce the loss of water. Pea is more nutritious and 2nd food source after cereals at Pakistan, but due to lake of proper management, yield is still not up to mark as compare to developed world. To reduce this problem, a field experiment was conducted to investigate the effect of mulching material and sowing dates on the yield of Pea. The study consisted of three different mulching materials (Polythene Black, Polythene Blue and Polythene Brown) with three different sowing dates (1st, 15th and 30th October) arranged in a Randomized Complete Block Design with three replications. The results showed that different sowing dates and mulching materials had significant effect on the yield parameters of Pea. Regarding sowing dates, maximum days to pod formation (8.08 days), pods plant^{-1} (21.25), Pod weight (18.84 g) and pod yield (4.39 tons ha^{-1}) were noted in pea sown on October 1st. Whereas, minimum data of days to pod formation (3.08 days), pod plant^{-1} (15.34), pod weight (13.17 g) and pod yields (2.69tons ha^{-1}) were recorded in pea sown on October 30th. In case of mulching types maximum number of pods plant^{-1} (19.00), pod length (6.89 cm), seeds pod^{-1} (7.78), pod weight (17.34 g) and pod yield (3.69 tons ha^{-1}) were observed in pea mulched with Polythene Black, while minimum pods plant^{-1}, pod length, seeds pod^{-1}, pod weight and pod yield were found in control. The study suggested that pea should be sown on October 1st while mulched with

Polythene Black to produce maximum yield and production in agro environment of district Peshawar.

Keywords

pea, mulches, sowing dates, yield

1. Introduction

Pea (*Pisum sativum* L.) belongs to family *leguminaceae* and is self-pollinated, herbaceous annual plant. Pea is an important Protein rich food source and second fiber crop after cereals (Khan, 1994). The USSR and China accounts 4 billion metric tons of the majority of estimated world production. In Pakistan, region under pea in 2013-2014 has been 9939 ha with production of 77166 tons with regular yield of 82 tons ha^{-1} (MINFA, 2013-2014).

To get better pod production, it is essential to conserve the optimum quantity of plants ha^{-1}. Seven to ten days are important for the young fresh fruit (pod) to get fully elongated. Pea might be grown with temperature amounts from 10 to 30^0C. It is usually sensitive to warm and drought strain. Well rotten farm yard manure applied at the rate of 20-25 tons ha^{-1} must be added. Seed rate regarding to early crop ranges from 100 to 120 and 80-90 kg ha^{-1} concerned to late planting. Badr et al. (2014) indicated that inoculated plants significantly surpassed un-inoculated ones in number of nodules $plant^{-1}$, plant height, number of branches and pods $plant^{-1}$, seed yield $plant^{-1}$, 100-seed weight and seed yield fed^{-1}. On the other hand, the number of seeds pod^{-1}, pod weight $plant^{-1}$, seed N content % and seed protein content % were not affected by inoculation. Furthermore, the NPK application in pea crop are typically increase the growth and production and give better green pod yield (Vorob, 2000). Management regarding weeds had been practiced in the very early times. These routines are time intensive, tiresome and expensive due to increased price of labor.

Plastic mulching directly affects the plant by improving the structure of the soil, decrease soil evaporation which results in a uniform soil water content and reduced the amount of irrigation (Liakatas et al., 1986). Mulching diminishes the risk of temperature in the 20-30 cm depth of soil, which helps in the roots development and maintain the soil temperature inside planting bed, promoting crop growth (Lamont, 1993). Recent advances in the use of coloured mulches exerted beneficial effects on crop growth and yield, because darker colour mulches increases soil temperature, while lighter colours reflect more solar radiation. Specific colours of mulches cause qualitative and quantitative differences in reflected light and its wavelengths, which showed to be effective growth and yield, as well as the presence of pests and/or pathogen populations (Decoteau et al., 1990; Greer & Dole, 2003). The use of coloured mulches may vary with plant species and environmental conditions (Decoteau et al., 1988; Mahmoudpour & Stapleton, 1997). Now a day majority of the farmer used the black polyethylene for mulching purpose because of its low density, resistance, flexibility and durability as compared to other polymers (Espı et al., 2006). The adverse effect of plastic mulching was its waste that cause environmental pollution and only a small amount of the agriculture plastic has been recycled because of its high cast, time consuming and needs a lot of labour for the proper recycling of plastic

after the harvest. Most of the farmer burnt the remaining plastic films that is left on the field, which produced harmful gases and pollute the environment (Scarascia-Mugnozza et al., 2006). The solution for the disposal of plastic mulch could be used the biodegradable plastic that are mostly made of polysaccharides, starch and cellulose. The biodegradable plastic film mulch when placed in contact with water and microorganism been decomposed by the bacteria and fungi in the soil (Scarascia-Mugnozza et al., 2004, 2006).

Keeping in view the importance of Pea in agriculture and issues regarding sowing times and mulching materials on the seedling germination and yield. Therefore, the main objectives of the study were: 1) to find the suitable sowing date, 2) to evaluate the effect of mulching material on yield of pea.

2. Materials and Methods

2.1 Experimental Design

A research project entitled "Response of Pea to different sowing dates and mulching materials" was carried out at Horticulture Research Farm, The University of Agriculture Peshawar during 2014-2015. The experiment was laid out in Randomized Complete Block (RCB) Design with three replications. There were two factors. Factor A consist of different sowing dates, i.e., October 1st, October 15th and October 30th. While Factor B consist of different plastic mulching treatments that were control, Polythene Black, Polythene Blue and Polythene Brown. Basic dose of N: P: K was applied @ (40, 50, 150 kg ha^{-1}). Phosphorous and Potassium were applied before sowing while nitrogen was applied in split doses, i.e., half before sowing and half after one month.

Table 1. Factors Selected for the Study

Factor A: Sowing dates	**Factor B: Mulching**
October 1st	Control
October 15th	Polyethylene Black (PE black)
October 30th	Polyethylene Blue (PE blue)
	Polyethylene Brown (PE brown)

2.2 Yield and Yield Components

Days to pod formation

Days to pod formation from flowering were counted for all treatments in each replication and average days to pod formation were calculated.

Number of pods plant^{-1}

The numbers of pods were counted on middle rows in each treatment and average pods/plants were calculated.

Pod length (cm)

Fifty pods were randomly selected in each treatment and then the length was measured in centimeters and average was calculated.

Total seeds pod^{-1}

Fifty pods were randomly selected in each treatment and the number of total seeds was recorded and average was calculated.

Pod weight plot^{-1} (g)

Weight of 100 seeds in each treatment was taken and average weight per 100 was calculated.

Pod yield (tons ha^{-1})

Seed yield per plot was taken and the seed yield per hectare was calculated from the seed yield plot^{-1}.

$$Yield\ (tons\ ha-1) = \frac{Plat\ yield\ (kg)}{Plat\ area\ (m^2)} \times 10{,}000\ m^2$$

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2.3 Statistical Analysis

The data were analyzed individually for each parameter by using statistical software Statistix 8.1, through Randomized Complete Block (RCB) design with two factorial arrangement. Means were compared by using Least Significant Difference (LSD) test at 0.05 level of probability (Steel & Torrie, 1980).

3. Results and Discussions

3.1 Days to Pod Formation

Sowing dates and mulching materials has significantly affected days to pod formation (Table 2). The data analysis of variance shows that mulching and sowing dates had significantly influenced the days to pod formation of pea cv. Climax, while its interaction had non-significant effect.

Regarding mulching techniques maximum days to pod formation (6.34 d) were recorded in control followed by (5.56 d) in peas mulched with PE blue and brown, while minimum days to pod formation (4.78 d) were observed in pea mulched with PE black. In pea the early pod formation due to early germination and maximum growth of plant mulched with PE black. Our results are supported by Bakh et al. (2009) who indicates the overall effects of various mulches of days to pods formation were similar with the only exception of PE black mulching.

Similarly, for sowing dates, most days to pod formation (8.08) were computed in pea sown on October 1st followed by (5.50) October 15th, while least days to pod formation (3.08) were recorded in pea sown

on October 30th. The early pod formation in pea sown may be due at the end of October was due to favorable climatic temperature. These results are in line with previous results of Baloch (1994) who investigate that, pea grow well in winter due to the availability of sufficient moisture, while hot and dry climatic conditions discourage its growth. Warm climate interferes to seed set and winter with the quality of pods formation.

Table 2. Effects of Different Sowing Date and Various Mulching on the Day to Pod Formation of Pea

Mulch Type	Sowing Dates			Mean
	1st Oct	15th Oct	30th Oct	
Control	8.67	6.00	4.34	6.34 a
Black Plastic	7.34	4.67	2.34	4.78 c
Blue Plastic	8.34	5.67	2.67	5.56 b
Brown Plastic	8.00	5.67	3.00	5.56 b
Mean	8.08 a	5.50 b	3.08 c	

LSD α 0.05 for Mulching=0.7102.

LSD α 0.05 for Sowing dates=0.6151.

3.2 Number of Pods Plant^{-1}

Sowing dates and mulching materials had significant ($p<0.05$) effects on number of pod plant^{-1} (Table 3). The data analysis of variance shows that mulching and sowing dates had significantly influenced the number of pods plant^{-1} of pea cv. Climax while its interaction had non-significant effects.

In mulching techniques, the maximum pods plant^{-1} (19.00) were observed in peas mulched with PE Black and then (18.45) PE Blue, while the minimum pods plant^{-1} (17.45) were recorded in pea for control. In PE Black mulch, the plant height, growth rate and number of flowers were more which leads to maximum number of pods plant^{-1} in pea. Same findings were reported by (Lamont, 1993) that PE Black mulching materials were significantly increased number of pods plant^{-1} due to maximum conservation of moisture for longer time. Because it can increase root length and decreased the soil temperature which results in a faster crop growth.

Moreover, for sowing dates more number of pods plant^{-1} (21.25) were noted in pea sown on October 1st followed by October 15th (18.42 pods plan^{-1}), while less number of pods plant^{-1} (15.34) were noted in pea sown on October 30th. The number of pods plant^{-1} was more in pea sown on October 1st, because for pea the optimum temperature range is 23-26^{0}C which is available in the start of October that's why

the number of pods plant^{-1} were high. These results were matched with Bhutia et al. (2017) who reported that in pea crop, more number of pods plant^{-1} are related with duration of vegetative growth and climate. So, therefore minimum number of pods per plant in delay sowing while maximum was recorded in early pea crop sowing.

Table 3. Effects of Different Sowing Date and Various Mulching on the Number of Pods Plant^{-1} of Pea

	Sowing Dates			
Mulch Type	**1st Oct**	**15th Oct**	**30th Oct**	**Mean**
Control	19.67	18.00	14.67	17.45 b
Black Plastic	22.00	19.00	16.00	19.00 a
Blue Plastic	21.67	18.34	15.34	18.45 a
Brown Plastic	21.67	18.34	15.34	18.45 a
Mean	21.25 a	18.42 b	15.34 c	

LSD α 0.05 for mulches=0.9923.

LSD α 0.05 for sowing dates=0.8594.

3.3 Pod Length (cm)

Pea pod length (cm) was significantly influenced by different sowing dates and mulching materials (Table 4). The data analyses of variance show that mulching and sowing dates had significantly influenced the pod length (cm) of pea cv. Climax while its interaction had non-significant observed.

Concerned to mulching techniques, the increased pod length (6.89 cm) were recorded for pea mulched with black and blue plastic followed by (6.67 cm) PE Brown, whereas lowest pod length (5.78 cm) was noted in pea for control. In PE Black mulch the pod length was higher because of high plant height and maximum vegetative growth which is linked with pod length. PE Black mulching have significantly affected the weeds growth and development due to facilitation of maximum nutrient uptake (Moreno & Moreno, 2008).

In sowing dates, the maximum pod length (7.75 cm) was noticed in pea sown on October 30th followed by (6.25 cm) October 15th, while the minimum pod length (5.67 cm) was reported in pea of October 1st. The maximum pod length at the end of October may be due to favorable temperature for pod development, more number of ovules fertilized and due to more vegetative growth. These results are inconsistent with Singh, R. and Singh, P. M. (2011) who stated that late sowing in October gave large size pods.

Table 4. Effects of Different Sowing Date and Various Mulching Materials on the Pod Length (cm) of Pea

Mulch Type	Sowing Dates			
	1st Oct	15th Oct	30th Oct	Mean
Control	5.00	5.67	6.67	5.78 b
Black Plastic	5.67	6.67	8.34	6.89 a
Blue Plastic	6.00	6.34	8.34	6.89 a
Brown Plastic	6.00	6.34	7.67	6.67 a
Mean	5.67 c	6.25 b	7.75 a	

LSD α 0.05 for mulches=0.5875.

LSD α 0.05 for sowing dates=0.5088.

3.4 Total Seeds Pod^{-1}

The tabulated data (Table 5) of different sowing dates and mulching materials had significant effects on pea total seeds pod^{-1}. The data analysis of variance shows that mulching and sowing dates had significantly influenced the total seeds pod^{-1} of pea cv. Climax while its interaction had non-significant observed.

In mulching techniques, the maximum seeds pod^{-1} (7.78) was reported in pea with PE Black mulched followed by (7.34) to PE Blue, whereas the minimum seeds pod^{-1} (6.23) were found in pea for control. PE Black mulch give positive response to the number of seeds pod^{-1} may be due to maximum nutrients in the soil, maximum plant height, high length of pods and sufficient moisture content in soil. This resultant value has conformity with Lamont (1999) who founded that maximum number of seeds pods^{-1} are recorded for with PE Black mulch as compare to other mulching techniques.

Similarly, for sowing dates highest total seeds pod^{-1} (8.92) were reported in pea sown on October 30th and then (6.84) October 15th, while the lowest total seeds pod^{-1} (5.50) were noticed in pea sown on October 1st. The highest number of seeds pod^{-1} in pea sowed on October 30th may be due to the favorable temperature and day length. According to Duke (1981) who suggested that pea vegetative growth is tolerate to maximum weather, but in smaller stage flower produce. So, the seeds and pods production were healthier due to high temperature the quantity and quality are inhibited. So therefore, early sowing is stronger to most favorable temperature with long pods resultant as maximum number of seeds pod^{-1}.

Table 5. Effects of Different Sowing Date and Various Mulching Materials on the Total Seeds Pod^{-1} of Pea

	Sowing Dates			
Mulch Type	**1st Oct**	**15th Oct**	**30th Oct**	**Mean**
Control	4.67	6.00	8.00	6.23 d
Black Plastic	6.34	7.34	9.67	7.78 a
Blue Plastic	6.00	7.00	9.00	7.34 b
Brown Plastic	5.00	7.00	9.00	7.00 c
Mean	5.50 c	6.84 b	8.92 a	

LSD α 0.05 for mulches=0.3068.

LSD α 0.05 for sowing dates=0.2657.

3.5 Pod Weight (g)

The organized data (Table 6) of sowing dates and mulching materials had significant effects on pea pod weight (g). The data analysis of variance shows that mulching materials and sowing dates had significantly influenced the pod weight of pea cv. Climax whiles its interaction had non-significant observed.

Concerned to mulching techniques, the highest pod weight (17.34 g) were observed for peas mulched with PE Black followed by (16.45 g) PE Blue, whereas the least pod weight (15.12 g) was reported in pea for control. The maximum pod weight in PE Black mulched pea may be due to maximum nutrient and soil moisture availability. Our findings were supported by Lamont et al. (2002) who stated that PE Black mulching techniques played main role to improve the yield and growth parameters in pea crops as maximum pod weight (g).

Moreover, for sowing dates highest pod weight (18.84 g) was noted in pea sown on October 1st followed by (16.42 g) October 15th, while the lowest pod weight (13.17 g) was observed in pea sown on October 30th. The maximum pod weight in pea sown on October 1st may be due to favorable temperature and day length. As day length and temperature decreased the pod weight of pea decreased. Our finding is with line Lamont et al. (2002) observed that earlier crop sowing in October are more effective for maximum pod weight (g) in pea and provides opportunity for double or triple-crop production.

Table 6. Effects of Different Sowing Date and Various Mulching Materials on the Pod Weight (g) of Pea

	Sowing Dates			
Mulch Type	**1st Oct**	**15th Oct**	**30th Oct**	**Mean**
Control	18.00	16.00	11.34	15.12 c
Black Plastic	20.00	17.00	15.00	17.34 a
Blue Plastic	19.00	17.00	13.34	16.45 ab
Brown Plastic	18.34	15.67	13.00	15.67 bc
Mean	18.84 a	16.42 b	13.17 c	

LSD α 0.05 for mulches=1.0199.

LSD α 0.05 for sowing dates=0.8833.

3.6 Pod Yield (Tons ha^{-1})

Sowing dates and mulching materials has significantly affected pod yield (tons ha^{-1}). The data analysis of variance shows that mulching materials and sowing dates had significantly influenced the pod yield (tons ha^{-1}) of pea cv. Climax while its interaction had non-significant effects (Table 7).

Pertaining mulching techniques, the highestpod yield (3.69 tons ha^{-1}) was noted in pea mulched with PE Black followed by peas mulched with PE Blue (3.62 tons ha^{-1}), whereas minimum pod yield was observed for control (3.09 tons ha^{-1}). The more pod yield in pea mulched with PE Black may be due to maximum soil nutrients and soil moisture availability as PE Black reserved the soil nutrients by damaging weed plants and retard its growth due to which the nutrients available in soil and weed plants became reserved. PE Black mulch in early stage are good for better yields and make crops free from weeds (Dittmar & McRae, 2012).

In the case of sowing dates, the highest pod yield (4.39 tons ha^{-1}) was observed in pea sown on October 1st and then (3.39 tons ha^{-1}) in pea sown on October 15th, while the lowest pod yield (2.62 tons ha^{-1}) was noted in pea sown on October 30th. The healthy pod yield in pea sown on October 1st may be due to favorable temperature and day length. Our finding is matched to (Singh, R. & Singh, P. M., 2011) they reported early sowing dates in October for peas healthier pod yields as compare to late and mid sowing dates.

Table 7. Effects of Different Sowing Date and Various Mulching Materials on the Pod Yield (Tons ha^{-1}) of Pea

Mulch Type	Sowing Dates			
	1st Oct	15th Oct	30th Oct	Mean
Control	3.90	3.07	2.30	3.09 c
Black Plastic	4.64	3.64	2.80	3.69 a
Blue Plastic	4.57	3.54	2.74	3.62 a
Brown Plastic	4.47	3.34	2.64	3.48 b
Mean	4.39 a	3.39 b	2.62 c	

LSD α 0.05 for mulches=0.0915.

LSD α 0.05 for sowing dates=0.0792.

4. Conclusion

The results of the present study concluded that the early sowing of pea showed highest number of pods plant^{-1}, pod weight and pod yield. In the case of mulches, PE Black mulching showed lowest days to pod formation, number of pods plant^{-1}, pod length, pod weight, pod yield and seeds pod^{-1} in pea. The early 1st week of October as compared to 15th and 30th showed better performance in pea. PE Black mulching technique showed better performance in pea as compared to PE Blue and Brown mulches.

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