

**Evaluation of post emergence application  
of pyribenzoxim against weeds in direct  
seeded rice under Kymore Plateau and  
Satpura Hill**

**THESIS**

*Submitted to the*

**Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur**

**In partial fulfilment of the requirements for the**

**Degree of**

**MASTER OF SCIENCE**

*In*

**AGRICULTURE**

**(AGRONOMY)**

*By*

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**2018**

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*This is to certify that the thesis entitled “Evaluation of post emergence application of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura Hill” submitted in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (Ag) in Agronomy** of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Miss. Rajul Soni** under my guidance and supervision. The subject of the thesis has been approved by the student’s Advisory Committee and the Director of Instruction.*

*All the assistance and help received during the course of the investigations has been acknowledged by the scholar.*

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**(RAJUL SONI)**

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## LIST OF ABBREVIATIONS AND SYMBOLS

<b>Abbreviation</b>	:	<b>Meaning</b>
/ or <sup>-1</sup>	:	Per
@	:	At the rate
a.i.	:	Active ingredient
B: C ratio	:	Benefit- cost ratio
CD	:	Critical difference
cm	:	Centimeter
CGR	:	Crop growth rate
<i>et al</i>	:	And other or co-worker
etc.	:	Etcetera
Eve.	:	Evening
Fig.	:	Figure
g	:	Gram
ha	:	Hectare
IUPAC	:	International Union of Pure and Applied Chemistry
J.	:	Journal
kg	:	Kilogram
LAI	:	Leaf area index
LAD	:	Leaf area duration
m	:	Metre
Max.	:	Maximum
Min.	:	Minimum
l	:	Liter
DAT	:	Days after transplanting
DAS	:	Days after sowing
g	:	Gram
NMR	:	Net monetary return
Mor.	:	Morning
ml	:	Mili gram
No.	:	Number
NPK	:	Nitrogen, Phosphorus, Potassium
q	:	Quintal
Rs	:	Rupees
NS	:	Non significant
°C	:	Degree centigrade
RBD	:	Randomized Block Design
RH	:	Relative Humidity
RGR	:	Relative growth rate
SLA	:	Specific leaf area
T	:	Treatment
Var.	:	Variety
Viz.,	:	Namely

## INTRODUCTION

Rice (*Oryza sativa* L.) is the plant belonging to the family Graminae. India is the 2<sup>nd</sup> largest producer and consumer of rice in the world. Based on the hydrology and topography of land the rice area is divided into various ecologies viz. Rainfed upland (16%), irrigated medium land (45%) and rainfed low land (39%). Rice plays a significant role in the economy of India and hence occupies a central position in national agricultural policy and food security (Dangwal *et al.* 2011). Rice provides 50-80% daily calorie intake to the consumer (Choudhary *et al.* 2011 and Juraimi *et al.* 2011). At present in India 43.39 million hectare area is under rice crop with production of 104.32 million tonnes with productivity 2404 kg/ha. In Madhya Pradesh rice grown about 2.02 million hectares area with the production of 3.58 million tonnes and productivity is 1768 kg/ha (Agriculture Statistics at a glance, 2016).

Direct seeded rice (DSR) has more benefits as compared to traditional transplanting like easier planting, timely sowing, early crop maturity by 7 to 10 days, less water requirement better soil physical condition for next crop and low production cost and more profit. Weeds are one of the limiting factor in direct seeded rice which reduced the yield upto 50-80% in rainfed uplands. Yield reduction was even higher upto 97% due to competition of *Echinochloa crusgalli* (Kurchania *et al.* 1991). Uncontrolled infestation of weeds in rice field reduced the grain yield by 75.8, 70.6 and 62.6% in dry seeded rice, wet seeded rice and transplanted rice, respectively (Singh *et al.* 2005).

The technology of direct seeded rice (DSR) is gradually finding favour with the farmers as it saves irrigation water and reduces the production cost. Direct seeded rice also allows early establishment of the succeeding wheat crop, reduces methane emission and ensures higher profit in areas with assured water supply ( Balasubramaniam and Hill,2002) but crop weed competition in this system is more severe, which reduces the yield by 20-95% (Gagoi *et al.*,2000).

Weeds are the major problem in rice field. *Echinochloa crusgalli*, *Cyperus iria*, *Cyperus difformis*, *Alternanthera sessilis* and *Commelina communis* were the dominant weeds present in upland rice at Jabalpur (Singh *et al.*1996).

Weed is as old as agriculture, and from the very beginning farmers realized the interference of weed with crop productivity, which led to the co-evolution of agro ecosystems and weed management (Ghersa *et al.*, 2004). The risk of yield loss from weeds in direct-seeded rice is greater than transplanted rice (Rao *et al.* 2007).

Weed competition is greater in direct seeded rice as weeds germinate along with rice and even grow faster than rice if timely and effective weed control is not done. Weed may smother the crop completely and crop may fail to give economic performance. In crop fields where the extent of weed infestation is more, the nutrient demands per unit land area exceeds then that the nutrient reserves in the soil.

A large number of weeds compete for nutrients, moisture and space causing considerable yield reduction of rice. Competition of weeds for longer period with rice causes severe yield reduction ranging from 29-48% depending on the weed infestation (Sunil *et.al.* 2010) as stated season- long weed competition in DSR may cause yield reduction up to 80%.

There are several reasons responsible for low productivity in direct seeded rice than puddle condition. Hand-weeding is a common method of weed control adopted by farmers but comparatively this method is time consuming and coupled with high wages and unavailability of labourers and also timely control of weeds is not possible by hand weeding. Under such conditions, the use of suitable herbicides is the only substitute to gain high productivity with low cost. An ample scope exists for the purpose of increasing productivity and reduce cost of cultivation (Mishra and Singh, 2016).

In DSR system, fairly good yields can be obtained if properly managed (Farooq *et al.* 2011). Control of weeds by herbicides is although quite effective but needs proper skill and fidelity. Generally pre emergence herbicides like

pretilachlor, butachlor, anilophos and post emergence herbicides like 2,4-D, and Almix are used frequently to control grassy and broad leaf weed in direct seeded rice. Continuous application of the herbicides may also results weed flora shift and development of herbicide resistance in weeds. Hence, there is a need to develop appropriate weed management practices through the new and alternate herbicides to overcome the problem of herbicidal resistance in weeds. Several studies reported that, to prevent the simultaneous emergence of weeds with the rice crop, pre emergence herbicides should be applied, which allow the crop to grow in a relatively weed-free environment in its early growth stages (Chauhan and Opena, 2013). A new herbicide has been launched in india for wide spectrum weed control in direct seeded rice. But the information on its efficacy against weeds in direct seeded rice is very meager.

Keeping in view all above facts there is a need to manage to weeds during critical crop - weed competition period either by physical method or chemical methods the present investigation entitled "Evaluation of post emergence application of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura Hill" has been proposed to conduct with the following objectives:

1. To study the associated weed flora in direct seeded rice(DSR)
2. To find out the suitable dose of pyribenzoxim for effective control of weeds in direct seeded rice (DSR)
3. To see the effect of weed control treatments on growth and yield of direct seeded rice (DSR)
4. To work out the economics of treatments

## REVIEW OF LITERATURE

As pyribenzoxim has been recently introduced in India for testing its efficacy in direct seeded rice there is meager literature on it. Therefore, effort has been made to review the available literature on efficacy of pyribenzoxim along with other herbicides against weeds in direct seeded rice. The same has been reviewed in this chapter on the following heads:

- 2.1. Weed flora in rice
- 2.2. Effect of herbicides on weeds
- 2.3. Effect of herbicides on crop growth and yield
- 2.4. Economics

### 2.1 Weed flora in rice

Singh *et al.* (1996) from a field trial at Jabalpur (M.P.) during 1991 and 1992 reported that *Echinochloa crusgallis*, *Cyperus iria*, *Cyperus difformis*, *Alternanthera sessilis* and *Commelina communis* were the dominant weeds present in upland rice.

Ghosh and Singh (1996) at Ranchi, Bihar found that *Echinochloa crusgalli*, *Echinochloa colona*, *Digitaria filiformis*, *Ludwigia parviflora*, *Marilea quadrifolia* and *Cyperus sp.* were predominant weeds in direct seeded rice.

Paradkar *et al.*(1997) revealed that *Parthenium hysterophorus* and *Alternanthera sessilis* among broad leaf weeds. *Echinochloa crusgallis* as grass, commonly infested the upland rice in several localities of Jabalpur.

Rana and Angiras (1997) noticed that *Echinochloa crusgalli* and *Echinochloa colona* were the most problematic weeds which constituted 23-24% of the total weed flora and an accumulation of the total weed dry weight (71.1%).

In a field experiment at Jabalpur (M.P.), Jain *et al.* (1998) found predominancy of weeds like *Echinochloa crusgalli*, *Cyperus iria* and *Commelina communis* in transplanted rice.

Tomar *et al.* (2002) at Lakhaoti (Utter Pradesh) reported the, experimental field was infested with *Echinochloa colona* among the grasses, *Trianthema portulacastrum* the non-grasses and *Cyperus iria* and *Cyperus rotundus* among the sedges were the dominating weeds flora of upland direct seeded rice.

Mahajan *et al.* (2003) reported that the rice field was dominated by *Cyperus spp.* (66.6%) and *Echinochloa crusgalli* (31.4%). The broad leaved weeds (5.0 %) present were *Caesulia axillaris* and *Commelina bengalensis*.

Bahar and Singh (2004) at Pantnagar found that the *Echinochloa colona* (30.8%) was only the rampant weed followed by *Ischaemum rugosum* (26.4%). However, other weeds like *Echinochloa crusgalli* (5.8%), *Caesulia axillaris* (10.3%), *Commelina diffusa* (7.6%) and others (8.9%) were present less in number.

Kathirvelan and Vaiyapuri (2004) reported in the experimental plots at Coimbatore major weeds were *Cyperus rotundus*, *Echinochloa colona*, *Leptochloa chinensis*, *Marsilea quadrifolia*, *Eclipta alba* and *Sphenoclea zeylanica*. While in the experimental field at Kaul (Haryana),

Ram *et al.* (2004) noticed that *Eleusine indica* (19.8%), *Dactyloctenium aegypticum* (16.9), *Echinochloa colona* (0.2%), *Corchorus actutangulus* (9.9%), *Alternanthera sessilis* (9.9%) and *Leptochloa chinensis* (8.0%) were the main weeds in rice.

Tomar and Saraiya (2007) at Tikamgarh (M.P.) reported that the major weeds flora of experimental field were *Echinochloa crusgallis*, *Echinochloa colona*, *Cyperus rotundus*, *Cynodon dactylon* and *Commelina benghalensis*.

Kiran and Subramanyam (2010) reported that the major weed species found in the experimental plots were *Echinochloa colonum* (L.) Link., *Digitaria sanguinalis* (L.) Scop., *Cyperus rotundus* L., *Cyperus difformis* L., *Cyperus iria* L., *Eclipta alba* (L.) Hassk. and *Ammania baccifera* L. All the herbicide treatments reduced the population and biomass of weeds substantially over unweeded check.

Singh *et al.* (2012) at Pantnagar noticed that *Echinochloa colona*, *E. crusgalli* and *Paspalum distichum* among grasses, *Caesulia axillaris* among broadleaf weeds and *Cyperus* spp. among sedges were the dominant weed species which constituted 18.8, 12.4, 11.7, 32.95 and 9.5 per cent, respectively of total weed population under weedy check at 60 DAT. The lowest total weed density ( $1.40 \text{ m}^{-2}$ ), dry matter production ( $1.37 \text{ g m}^{-2}$ ) and higher weed control efficiency irrespective of weed species was recorded under two hand weeding.

Anwar *et al.* (2013) conducted field experiment at Mountain Research Centre for Field Crops, SKUAST-K, Khudwani, Kashmir and found that the major weed species infesting the field were *Echinochloa crusgalli*, *Echinochloa colona*, *Cyperus iria*, *Cyperus difformis*, *Marsilea quadrifolia*, *Potamogeton distinctus*, *Ammania baccifera* and *Monochoria vaginalis*.

Kumar *et al.* (2013) while studying at mid-hill conditions of Himachal Pradesh and found that the major associated weeds were *Echinochloa colona* (31.1%) and *Commelina benghalensis* (7.3%) among grasses, *Cyperus iria* (26.9%) and *Cyperus difformis* (9.3%) among sedges and *Ammania baccifera* (8.8%) among broad-leaved weeds, *Aeschynomene indica*, *Monochoria vaginallis* and *Bulbostylis barbata* were the other broad-leaf weeds as a whole constituted 16.6% of the total weed flora.

Kabdal *et al.* (2014) observed that the experimental plots at Pantnagar, the dominant weeds were *Echinochloa colona*, *E. crusgalli*, *Ischaemum rugosum*, *Caesulia axillaris*, *Ammania baccifera*, *Alternanthera sessilis* and *Cyperus iria* were the dominant weeds in the experimental plots at Pantnagar.

Duary *et al.* (2015) conducted field experiment during the *kharif* (wet) season at Agricultural Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal. From the experimental findings it revealed that *Echinochloa colona* and *Digitaria sanguinalis* among the grasses, *Cyperus difformis* and *Cyperus iria* among the sedges and *Ludwigia parviflora* among the broadleaved weeds were predominant throughout the cropping period.

Kraehmer *et al.* (2016) stated that the weedy rice (*Oryza sativa* L.) and herbicide resistance have become general global problems within the last decades. Some global key weed genera such as *Echinochloa*, *Cyperus*, *Scirpus*, or *Fimbristylis* species were predominant, however, still dominating rice fields despite the decade long use of well performing herbicides.

Punia *et al.* (2016) studied that 28 weed species (7 grassy, 7 sedges and 14 broadleaf) were found to infest rice fields in Haryana. Grassy weeds *Echinochloa colona* and *Echinochloa glabrescence* were major weeds found to infest rice fields in all the districts. Similarly, *Ammania baccifera* with values of 1.6-36.8 among broadleaf weeds and *Cyperus rotundus*, *Cyperus difformis* among sedges were also present in all the districts.

On the basis above review it may be concluded that weed flora in direct seeded rice varies depending upon soil type, agro-climatic condition and management practices. The most common weeds observed in rice crop include *Echinochloa colona*, *Echinocolona crusgallis*, *Cynaodon dactylon*, *Cyperus spp.*, *Commelina benghlensis*, *Eclipta alba*, *Alternanthera sessilis*, *Phyllanthus niruri* and *Caesulia axillaris*.

## **2.2 Effect of herbicides on weeds**

Effectiveness of herbicide to control weeds in rice depends on its optimum dose, right time of application and prevailing climatic conditions. The later (i.e. climatic conditions) greatly affect the development of crop and the emergence as well as growth of weeds. Several herbicides including pyribenzoxim, fenoxaprop-p-ethyl and oxadiargyl were found effective for weed control in direct seeded rice.

Jordan *et al.* (1995) reported that post-emergence application of fenoxaprop-p-ethyl 56, 75 or 94 g ha<sup>-1</sup> resulted effective control of *Echinochloa colona* as compare to bensulfuron 52 g ha<sup>-1</sup> fenoxaprop-p-ethyl caused slight phytotoxicity in rice plants, but the crop recovered within 14-21 days after application.

Kuah and Sallehuddin. (1998) conducted trials in Malaysia where fenoxaprop-p-ethyl 0.05-0.10 lit ha<sup>-1</sup> applied at 14-15 days after sowing of

rice provided excellent control of *Echinochloa crusgalli* and *Echinochloa colona* in dry and flooded condition.

Rana *et al.* (2000) reported that application of Fenoxaprop-p-ethyl @ 60g/ha + Ethoxysulfuron @ 15g ha<sup>-1</sup> or Fenoxaprop-p-ethyl @ 60g/ha at 15 DAT provided 80 and 75% control of grassy weeds like *Echinochloa colona* and *Paspalum distichum*, respectively. On the other hand, Ethoxysulfuron @ 30g/ha gave better control of *Scirpus difformis* (88%) *Cyprus iria* (100%) *Cyprus defformis* (100%) and *Ammania baccifera* (80%).

Bhowmick *et al.* (2000) reported that pre-emergence application of oxadiargyl (0.1 kg ha<sup>-1</sup>) significantly reduced weed density (14.6 m<sup>-2</sup>) and weed biomass (0.17 t ha<sup>-1</sup>) in rice.

Moon Byeong-Chul (2002) reported that Cyhalofop/bentazon ME and pyribenzoxim EC were originally developed as foliar-applied herbicides to control weeds at 4-5 leaf stages of barnyard grass 20-25 days, after seeding (DAS) in direct-seeding culture but further possible utilization of these two herbicides, the application of cyhalofop/bentazon ME and pyribenzoxim EC at right after rice emergence and the 2-3 leaf stages of rice had an excellent weed control efficacy with above 90% up to 30 DAS without a phytotoxicity of rice plant and the control efficacy of over 80% was maintained until 60 DAS.

Sainy and Angiras. (2002) conducted a field experiment in Himachal Pradesh to evaluate the use of fenoxaprop-p-ethyl against grassy weeds in directly sown puddle rice (cv.HPU-2216). The population of *Echinochloa crusgalli* and *Panicum dichotomiflorum* was less in treated plots than in weedy control. Fenoxaprop-p-ethyl at 90 g ha<sup>-1</sup> (20 and 25 DAS) was at par with fenoxaprop-p-ethyl at 75g ha<sup>-1</sup> (20 and 25 DAS), which produced significant lower weed dry weight than other treatments.

Jana *et al.* (2002) reported that chemical method of weeds control may be quit feasible, effective and economical in direct seeded rice. Several promising herbicides gave sown an excellent control of weeds.

Angiras *et al.* (2005) concluded that pre-emergence application of oxadiargyl @ 10 g ha<sup>-1</sup> reduced weed population of *Aeschynomene indica*

and significantly reduced total weed count of grasses, sedges and broad leaved weeds. The herbicide markedly reduced weed dry matter but it was less effective than hand weeding and post-emergence application of Pyrazosulfuron ethyl on silty clay loam soils at Palampur, Himachal Pradesh.

Ranjit and Suwanketenikom (2005) from Nepal reported that both Anilophos and Bispyribac-sodium were found effective to reduce narrow leaved weeds compared to unweeded control. Anilophos+ hand weeding, straw mulch+ Bispyribac-sodium, hand weeding twice and Bispyribac-sodium alone gave higher yield compared to weedy check.

Herath *et al.* (2005) at Batalagoda, Sri Lanka showed that the application of pretilachlor + pyribenzoxim ( $300\text{g a.i ha}^{-1} + 20\text{ g a.i ha}^{-1}$  EC) at three rates 1, 1.25 and  $1.5\text{ l ha}^{-1}$  compared with bispyribac sodium 100 SC at  $100\text{ ml ha}^{-1}$ ; and the combination of herbicide Propanil 36% EC ( $7.5\text{ l ha}^{-1}$ ) followed by (*fb*) MCPA 40% SL ( $2.5\text{ l ha}^{-1}$ ), un-weeded and hand weeded controls. The results indicated that pretilachlor + pyribenzoxim at the rate of  $1.25 - 1.5\text{ l ha}^{-1}$  effectively controlled of wide range of weeds with excellent selectivity in broadcasted rice in Sri Lanka.

Subramanyam *et al.* (2007) observed that oxadiargyl  $75\text{ g ha}^{-1}$  supplemented with hand weeding at 40 DAT recorded less weed dry weight ( $3.83\text{ g m}^{-2}$ ) and higher grain yield over herbicide application alone and on a par with hand weeding twice (20 and 40 DAT).

Rao *et al.* (2007) found that oxadiargyl is effective against many annual broadleaf and grassy weeds. It inhibits protoporphyrinogen oxidase (PPO) with general recommendation of  $100\text{ g a.i ha}^{-1}$

Walia *et al.* (2008) noticed that pre-emergence application of oxadiargyl @  $90\text{ g a.i. ha}^{-1}$  significantly reduced weed dry weight ( $5.50\text{ q ha}^{-1}$ ), which is superior to all other post-emergence herbicides studied viz., bispyribac sodium  $25\text{ a.i. ha}^{-1}$  ( $10.78\text{ q ha}^{-1}$ ), penoxsulam  $20\text{ g a.i. ha}^{-1}$  ( $14.30\text{ q ha}^{-1}$ ) and azimsulfuron  $25\text{ g a.i ha}^{-1}$  at ( $11.29\text{ q ha}^{-1}$ ) at Ludhiana, Punjab.

Damalas *et al.* (2008) in a study at Greece found that Bispyribac-sodium ( $24\text{ to }34\text{ g ha}^{-1}$ ) applied alone at the three to four leaf stage provided

89 to 100% control of early water grass and 84 to 100% control of late water grass.

Dewangan (2011) reported that maximum panicle length, number of seeds/panicle, WCE and minimum weed density, dry matter accumulation obtained under post-emergence application of fenoxaprop-p-ethyl ( $60 \text{ g ha}^{-1}$ ) + ethoxysulfuron ( $15 \text{ g/ha}$ ) favoured significant enhancement in seed yield which was at par with hand weeding.

Abraham *et al.* (2012) reported that fenoxaprop-p-ethyl at all the tested doses was effective in controlling *Echinochloa* spp. Fenoxaprop sprayed @  $60.38 \text{ g ha}^{-1}$  recorded yields at par with hand weeding and also with standard check cyhalofop.

Mishra *et al.* (2016) found that among different herbicides fenoxaprop + (chlorimuron + metsulfuron) and cyhalofop butyl + (chlorimuron + metsulfuron) were best herbicides for direct seeded rice from economics and environmental point of view and also recorded lower persistence of escaped weeds indicating broad spectrum effect in controlling the weeds

Bandara *et al.* (2016) at Manapaha in Kurunegala District evaluate and show performances of different weed management practices in machine transplanted rice cultivation. The demonstration had 07 treatments [T1=Pretilachlor 300g/l+Pyribenzoxim 20g/l followed by weeding twice, T2= Pretilachlor 300g/l +Pyribenzoxim 20g/l, T3= Pretilachlor 300g/l EC, T4= Pretilachlor 300g/l EC followed by weeding twice, T5=Weeding twice (at 2 Weeks After Transplanting (2WATP) and 4 Weeks After Transplanting (4WATP), T6=Hand-weeding and T7=No-weeding]. All treatments ultimately gave a significantly higher yield than no-weeded control, and *Pretilachlor 300g/l EC* was well performed among all herbicide treatments in machine transplanted rice.

### **2.3 Effect of herbicides on Crop growth and yield**

Control of weeds in rice by hand weeding is the most efficient and common practice though it is laborious, time consuming and costly.

From the field experiment at IARI, New Delhi, Chandar and Pandey (1996) reported that the manual weeding cause maximum reduction in weed

population and weed dry weight which resulted in increased grain yield of both transplanted and direct seeded puddled rice.

While conducting research on weed management, at Jabalpur, Agrawal and Sharma (1997) revealed that hand weeding twice (20 and 45 DAT) was most effective for controlling weeds and achieving good yield of transplanted rice.

Chandra *et al.* (1998) stated an efficiency of 93.9% can be achieved by manual weeding at 25 and 40 DAS in direct-seeded puddled rice. Whereas, Gnanavel and Kathiresan (2002) observed the least weed counts and highest WCE (69.9 and 70.1% during first and second season, respectively) due to removal of all sort of existing weeds through hand weeding twice.

Gagoi *et al.* (2000) observed that hand weeding twice resulted in significantly higher effective tillers, number of fertile grains panicle<sup>-1</sup> and thereby significantly higher grain yield up to 23.9 q ha<sup>-1</sup> over weedy check. Among the herbicide treatments, butachlor+propanil mixture controlling the weeds as evident from the WCE(74.6%) number of effective tillers m<sup>-2</sup>, panicle length and number of fertile grains/panicle. Butachlor+ Propanil each 1.12 kg a.i. ha<sup>-1</sup> gave the maximum extra net return up to Rs. 3457 ha<sup>-1</sup> over weedy check.

From Hyderabad, Rekha *et al.* (2002) reported lower weed density and dry weight under hand weeding twice (20 and 40 DAS) compared to that of herbicidal treatment and weedy plots. Similarly, Singh *et al.* (2002) noticed that hand weeding at 20 and 40 DAS resulted in the lowest weed dry matter (78.3 g m<sup>-2</sup>), highest weed control efficiency (78.3%), grain yield (30.1 q ha<sup>-1</sup>), straw yield (42.4 q ha<sup>-1</sup>) and gross income (Rs 15,050 ha<sup>-1</sup>) in direct seeded rice.

Chandra and Solanki (2003) observed that hand weeding (once) had the highest panicle bearing tillers m<sup>-2</sup> (112.33), while hand weeding (twice) gave the highest panicle length (23.49 cm), number of grains panicle<sup>-1</sup> (138.66), grain weight panicle<sup>-1</sup> (2.80), test weight (20.33 g), grain yield

(33.65 q ha<sup>-1</sup>), straw yield (65.36 q ha<sup>-1</sup>) and harvest index (33.97 %) in direct-sown flooded rice.

Singh and Prajapati (2006) revealed that hand weeding twice at 20 and 40 DAS was most promising to reduce the weed count (6.5 m<sup>-1</sup>) and weed dry weight (32.5g m<sup>-1</sup>) with the highest weed control efficiency (WCE) up to 83.1%.

Mishra and Singh (2016) reported that application of herbicides+one hand weeding or sequential application of herbicides significantly reduces the population of *Echinochloa colona*, *Cyperus iria* and *Cyperus communis* as well as total weed population compared with the weedy check.

Yadav *et al.* (2009) in a field experiment at Karnal revealed that Bispyribac-sodium applied at 15 or 25 DAT was found equally effective against grassy weeds but controlled of broad-leaved and sedges were controlled comparatively more when applied 15 DAT Bispyribac-sodium 25g ha<sup>-1</sup> or 25 DAT increased grain yield (174 to 199%) of rice over weedy check.

Soni *et al.* (2012) observed predominance of weeds like *Echinochloa crusgalli*, *Cyperus iria*, *Cenchrus axillarius*, *Commelina communis* and *Eclipta alba* in transplanted rice in Jabalpur (M.P.). The results showed that twice hand weeding at 20 and 40 DAT found best for weed control in transplanted rice. The control plot where no weed control practices was done, reduced 53.40% crop yield due to infestation of these weed flora, however mechanical (hand hoeing at 20 DAT) and chemical (chlorimuron ethyl 12 g weed ha<sup>-1</sup>) control treatments recorded lowest crop yield reduction 6.31 and 7.71%, respectively.

Chauhan *et al.* (2013) observed that the Crop parameters like number of effective tillers m<sup>-2</sup> (185.2), grains panicle<sup>-1</sup> (162.7) and 1000 grain weight (25g ha<sup>-1</sup>) was found higher under hand weeded treatments which was at par with the treatments where hand hoeing was done at 20 and 40 DAT.

Chauhan and Opena (2013) reported that weed competition in the control plots (one hand-weeding) lowered yield by 39–41% compared with the weed-free plots. All herbicides significantly reduced weed biomass

compared with the control treatment, providing 75–93% weed control efficiency. Herbicide treated plots had similar grain yield and the yield in these plots was 76–86% of the yield of the hand weeded plots (4.2–4.4 t ha<sup>-1</sup>).

Kumar *et al.* (2013) recorded the maximum mean grain yield (5.91 t ha<sup>-1</sup>) from the plots where two hand weeding at 20 and 40 DAT was performed and was statistically at par with the mean grain yield obtained under different weed management practices bispyribac-sodium @ 70 g a.i ha<sup>-1</sup>.

Duary *et al.* (2015) stated that lowland rice ecosystem in India is infested with complex weed flora including semi-aquatic and aquatic weeds. Recently weeds having mimics with rice, perennial and other weeds which propagate by vegetative means are emerging as major threat. Weeds cause yield losses from 15 to 76% in rice crop. Besides, weeds remove about 21-42 kg N, 10-13.5 kg P and 17-27 kg K ha<sup>-1</sup> in transplanted rice.

From the above findings it may be concluded that hand weeding twice (20 and 40 DAT) is most effective to control weeds and to achieve good yield of direct seeded rice

## **2.4 Economics**

From Hyderabad, Rekha *et al.* (2002) reported lower weed density and dry weight under hand weeding twice (20 and 40 DAS) compared to that of herbicidal treatment and weedy plots. Similarly, Singh *et al.* (2002) noticed that hand weeding at 20 and 40 DAS resulted in the lowest weed dry matter (78.3 g m<sup>-2</sup>), highest weed control efficiency (78.3%), grain yield (30.1 q ha<sup>-1</sup>), straw yield (42.4 q ha<sup>-1</sup>) and gross income (Rs 15,050 ha<sup>-1</sup>) in direct seeded rice.

Singh *et al.* (2004) reported that *Echinochloa colona*, *Echinochloa crusgalli* and *schaemum rugosum* were effectively controlled by fenoxaprop at 56.25 g ha<sup>-1</sup>. Application of fenoxaprop at 56.25 g ha<sup>-1</sup> 10 days after rice transplanting also produced significantly more grain yield than application done at 20 days after transplanting.

Subramanyam *et al.* (2007) observed that oxadiargyl 75 g ha<sup>-1</sup> supplemented with hand weeding at 40 DAT recorded less weed dry weight (3.83 g m<sup>-2</sup>) and higher grain yield over herbicide application alone and at par with hand weeding twice (20 and 40 DAT).

Soni *et al.* (2012) observed predominance of weeds like *Echinochloa crusgalli*, *Cyperus iria*, *Ceasulia axillarius*, *Commelina communis* and *Eclipta alba* in transplanted rice in Jabalpur (M.P.). The results showed that twice hand weeding at 20 and 40 DAT found best for weed control in transplanted rice. The control plot where no weed control practices was done, reduced 53.40% crop yield due to infestation of these weed flora, however mechanical (hand hoeing at 20 DAT) and chemical (chlorimuron ethyl 12 g ha<sup>-1</sup>) weed control treatments recorded lowest crop yield reduction 6.31 and 7.71%, respectively.

Sah *et al.* (2012) conducted a field experiment during *Kharif* 2005 & 2006 at Zonal Research Station, Chianki, Palamau (Jharkhand), to evaluate the hand weeding twice (20&40DAS) are give more dry matter accumulation and increasing weed control efficiency & 80.1% increase in grain yield, net returns (Rs. 18070 ha<sup>-1</sup>) and benefit cost ratio (1.99) was recorded in two hand-weeding respectively over weedy check. Two hand weeding although significantly reduced weed density & their biomass and increased the grain yield, owing to higher labour cost reduced the benefit cost ratio.

Walia *et al.* (2012) found that pre-emergence application of pendimethalin 0.75 kg ha<sup>-1</sup> or oxadiargyl 0.90 g ha<sup>-1</sup> with post-emergence application of bispyribac 25 kg ha<sup>-1</sup>, azimsulfuron 20 g ha<sup>-1</sup> and 2,4-D 0.5 kg ha<sup>-1</sup> resulted in significant reduction in dry matter of weeds and increased grain yield.

Jacob *et al.* (2014) conducted field experiment during rabi season in a farmer's field in the Kole lands at Pullu in Thrissur district during the period November 2012 to March 2013. The treatments included application of post emergence herbicides. The herbicides cyhalofop butyl, fenoxaprop- p-ethyl, metamifop, penoxsulam, bispyribac sodium and azimsulfuron, are post emergence in action and were sprayed at 20 DAS. Hand weeded (hand

weeding at 20 and 40 DAS) and unweeded controls were also included for comparison with the herbicide treatments. The best herbicide for control of grassy weeds was fenoxaprop-p-ethyl @ 60 g a.i. ha<sup>-1</sup> applied at 20 DAS. Broad spectrum weed control can be made possible by spraying herbicide combinations that could give higher yield and B:C ratio.

## MATERIALS AND METHODS

The present investigation entitled “**Evaluation of post emergence application of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura Hill**” was conducted during *kharif* 2017 under edaphic and climatic conditions of Jabalpur (M.P.). The material used and methodology adopted during the course of investigation are presented in this chapter under the appropriate heads.

### 3.1 Experimental site

The experiment was conducted at the Krishi Nagar Research Farm, Department of Agronomy, JNKVV, Jabalpur during *kharif* season 2017. The topography of experimental field was fairly uniform. The field selected for experimentation was uniformly infested with localized specific weeds.

### 3.2 Climate and weather conditions

Jabalpur is situated at 23<sup>0</sup>90' North latitude and 79<sup>0</sup>58' East longitude with an altitude of 411.78 metre above the mean sea level. The climate of locality is characterized as typically semi humid and sub tropical, which is featured by hot dry summer and cool dry winter. It is classified as “Kymore Plateau and Satpura Hills” agro-climatic zone, as per norms of National Agriculture Research Programme. According to National Bureau of soil survey and land use planning (NBSS & LUP), Nagpur, this area belongs to agro ecological region number 10, named as Central High Land (Malwa and Bundelkhand) sub region named as hot sub-humid (dry) eco-region (Malwa plateau, Vindhayanchal Scarp land and Narmada Valley).

The annual average rainfall of Jabalpur is 1350 mm, mostly received between mid-June to end of September with a little and occasional rains in remaining parts of the year. The mean monthly temperature goes down to the extent of 4 °C during winter, while the maximum temperature reaches as high as 45 °C during the summer. Generally, relative humidity remains very low during summer (15 to 30%), moderate during winter (60 to 75%) and attains higher values (80 to 95%) during rainy season.

### 3.2.1 Meteorological data:

**Table 3.1: Weekly meteorological parameters during crop season (Kharif 2017)**

Months	Meteorological Weeks	Temperature (°C)		Relative humidity (%)		Sunshine (hrs/Day)	Rainfall (mm)	No. of rainy days
		Max.	Min.	Mor.	Eve.			
July	27.0	31.3	24.6	82	66	3.4	8.4	1
	28.0	30	23.6	90	81	3.3	95.2	5
	29.0	30.6	24	93	76	5.3	230	5
	30.0	28.8	22.9	90	74	1.4	86.3	6
	31.0	30.6	23.9	87	68	3.5	23	1
Aug	32.0	29.8	23.9	89	74	3.6	101.2	3
	33.0	30.9	23.7	87	67	3.6	7.8	1
	34.0	31.6	23.9	90	67	5.9	72.4	3
	35.0	31.3	23.7	90	65	3.9	22	3
Sept	36.0	32.5	24	88	65	7.1	1.5	0
	37.0	32.8	23.3	91	64	5.4	87.8	2
	38.0	30.7	22.4	90	73	3	98.3	3
	39.0	32.9	21.9	89	52	9.3	0	0
Oct	40.0	33.4	20.3	90	51	8.9	7.4	1
	41.0	32.6	21.7	92	56	8.4	9.2	1
	42.0	33.6	17.9	87	40	8.8	0	0
	43.0	33.1	15.9	81	26	8.9	0	0
	44.0	31.1	12.2	87	29	8.4	0	0
Total	—	—	—	—	—	—	850.5	35

Source : Deptt. of Physics and Agro-meteorology, College of Agricultural Engineering, J.N.K.V.V., Jabalpur (M.P.).

The meteorological data are presented in Table 3.1 and Fig. 1 which was obtained from Department of Physics and Agro-meteorology, College of Agricultural Engineering, J.N.K.V.V., Jabalpur (M.P.). It consists of rainfall, rainy days, relative humidity (morning and evening), maximum and minimum temperature and sunshine hours occurred during the cropping season.

### **3.2.2 Weather conditions during crop season**

Seasonal variations prevailing during the growth period play an important role not only in the growth and development of the crop, but also in the intensity of weeds which ultimately influence the final yield of crop. The weekly meteorological data during crop season were recorded at Meteorological Observatory, College of Agriculture Engineering, Jabalpur and presented in Table 3.1 and graphically illustrated through Fig. 1.

It is evident from the data that weather conditions were favorable for the growth and development of the rice crop. The monsoon commenced in the first week of July and terminated in the third week of October. The total rainfall received during the crop season was 850.5 mm, which was received in 35 rainy days from June to last week of October. During crop season, minimum and maximum temperatures observed was 12.2<sup>0</sup>C and 33.8 <sup>0</sup>C.. During this period, the average relative humidity was 82 to 93 percent in the morning and 26 to 81 percent in evening. Sunshine hours ranged from 0.0 to 9.3 hours per day.

### **3.3 Soil**

Prior to start of the experiment representative soil samples were drawn from 0-15 cm depth with the help of soil auger to know the textural class and inherent fertility status of the experimental field. These soil samples were then thoroughly mixed to get the composite sample. Requisite quantity of the soil from the composite samples was dried in sun and grinded with the help of mortar and pestle. Then these samples were subjected to analysis for physico-chemical properties of the soil as per standard methods adopted in the laboratory of Department of Soil science and Agricultural Chemistry, College of Agriculture, JNKVV, Jabalpur. The values obtained from the analysis are given in Table.3.3.

**Table 3.2: Physico-chemical properties of the experimental field**

Constituents	Value	Interpretation	Method of analysis
<b>A. Mechanical method</b>			
Sand (%)	40.00	Sandy loam	International pipette method (Piper, 1967)
Silt (%)	40.00		
Clay (%)	20.00		
<b>B. Chemical analysis</b>			
Organic carbon (%)	0.58	Medium	Walkley and Black rapid titration method (Walkley and Black, 1934)
Available nitrogen (kg ha <sup>-1</sup> )	280.29	Medium	Alkaline permagnate method (Subbiah and Asija, 1956)
Available Phosphorus (kg ha <sup>-1</sup> )	19.50	Medium	Calorimeter method (Olsen et al., 1954)
Available Potassium (kg ha <sup>-1</sup> )	269.10	Medium	Flame photometer method (Chapman and Pratt, 1961)
Soil pH (1:2.5 soil water ratio)	6.78	Neutral	Glass electric pH meter (Piper, 1967)
Electrical Conductivity (dS m <sup>-1</sup> )	0.34	Normal	Solu-bridge method (Black, 1965)

It is clear from the data that the soil of the experimental field was sandy clay loam in texture, medium in organic carbon (0.58%) and available nitrogen (280.29kg ha<sup>-1</sup>), available potassium (269.10kg ha<sup>-1</sup>) and available phosphorus (19.50 kg ha<sup>-1</sup>). It was neutral soil reaction (6.78 pH) and normal in electrical conductivity (0.34 dS m<sup>-1</sup>).

### 3.4 Previous history of the experimental field

The crops grown along with the fertilizer dose applied during last three years are given in Table.3.4.

**Table 3.3: Cropping history of the experimental field**

Year	Cropping system		Fertilizer dose (NPK kg ha <sup>-1</sup> )	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
2014-15	Rice	Wheat	120:60:40	120;60;40
2015-16	Rice	Wheat	120:60:40	120:60:40
2016-17	Rice	Wheat	120:60:40	120:60:40
2017-18	Present Experiment			

It is obvious from the information given in Table 3.4 that common cropping system (i.e. Rice-Wheat) with a uniform and recommended dose of fertilizer application (to each crop) was practiced during the last three years in the experimental field. Thus, it can be said that the fertility status of the experimental field was almost homogenous under all treatments before conduction of the present investigation

### 3.5 Experimental details

Location : Krishi Nagar Research Farm, Department of Agronomy, JNKVV, Jabalpur (M.P.).

Treatments: Eight weed control treatments

#### Treatment details of the experiment

Treatment No.	Treatment Name	Dosage (g a.i. ha <sup>-1</sup> )	Dosage(formulated product)(g or ml ha <sup>-1</sup> )
T1	Pyribenzoxim 5%EC	25.00	500
T2	Pyribenzoxim 5%EC	30.00	600
T3	Pyribenzoxim 5%EC	35.00	700
T4	Pyribenzoxim 5%EC	60.00	1200
T5	Fenoxaprop-p-ethyl 6.7% EC	56.95	812.5
T6	Oxadiargyl 80%WP	100	125
T7	Hand weeding twice	15 and 35 DAS	-
T8	Control	-	-

Experiment design	:	Complete Randomized Block Design (RBD)
Replication	:	03
Season	:	Kharif (2017)
Crop	:	Rice
Variety	:	MTU 1010
Gross plot size	:	5.25 m x 3.60 m
Net plot size	:	4.25 m x 2.80 m
Row Spacing	:	20 cm
Spacing between the replication	:	1.5m
Spacing between the plot	:	1m
Fertilizer Dose	:	120:60:40 (N : P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O) kg ha <sup>-1</sup>

### **3.5.2 Layout of the experiment**

The experiment was laid out in randomized block design with eight treatments replicated thrice.. The details of the treatments and symbols used are given as under

### **3.6 Agronomic characteristics of rice variety “MTU 1010”**

It is a early maturing variety (105-110 days). The plant height is 103cms. Its grain type is long slender, bold grains with cooking quality. It is high yielding variety of rice and suitable for both kharif and rabi season.

Test weight is 22-24 g. It has high yield potential (40-45 q ha<sup>-1</sup>) under good agronomic management and is recommended for cultivation in Madhya Pradesh. It is suitable as upland rice, as well as in irrigated mid land regions and also suitable for North and South regions.

### **3.7 Field preparation**

#### **3.7.1 Preparation of main field**

After harvest of previous crop, the field was worked out with the help of tractor drawn cultivator followed by two cross harrowing to break the clods and mix the left over crop residues in the soil. The field was impounded with

water and puddled with the help of tractor mounted puddler. Finally it was leveled with leveler and thereafter, the experiment was laid out according to plan of layout as given in Fig. 2.

### 3.7.3 Field operations

The different field operations performed during the course of present investigation are given in chronological order in Table 3.4.

**Table 3.4: Schedule of field operations done during the course of experimentation**

S. No.	Field operations	Date
1	Land preparation	
a.	Harrowing with cultivator	01.07.2017
b.	Harrowing with disc harrow and leveling	01.07.2017
c.	Layout of the experiment	02.07.2017
2.	Application of fertilizers	04.07.2017
3.	Seed treatment and sowing of seeds	04.07.2017
4.	Application of herbicide	19.07.2017
5	1 <sup>st</sup> Hand weeding at 15 DAS	19.07.2017
	2 <sup>nd</sup> Hand weeding at 35 DAS	08.08.2017
6.	Top dressing of urea 1 <sup>st</sup>	19.07.2017
	Top dressing of urea 2 <sup>nd</sup>	09.08.2017
7.	Harvesting of crop	23.10.2017
8.	Threshing and winnowing of produce	26.10.2017

### 3.7.4 Fertilizer application

Recommended dose of plant nutrients (viz. nitrogen, phosphorus and potash) for rice were given through urea, single super phosphate and muriate of potash, respectively. Half of the nitrogen ( $60 \text{ kg N ha}^{-1}$ ) and full dose of phosphorus ( $60 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$ ) and potassium ( $40 \text{ kg K}_2\text{O ha}^{-1}$ ) was applied at the time of sowing and remaining quantity of N was divided in two

equal splits and top dressed at tillering and panicle initiation stage of the crop.

### **3.8 Sowing management**

#### **3.8.1 Seed treatment**

Before sowing the seed was treated with carbendazim @ 2.0 g kg<sup>-1</sup> of seed.

#### **3.8.2 Sowing time and sowing method**

Sowing of seed was done with seed drill on July 4, 2017 which was done in such a manner that regulated for each plot using a seed rate 70 kg ha<sup>-1</sup>. Sowing of seeds in each plot was done in rows 3 cm apart at the depth 2-3 cm and then seeds were covered with fine soil. There was light rainfall after sowing which helped in proper germination of seeds.

#### **3.8.3 Thinning**

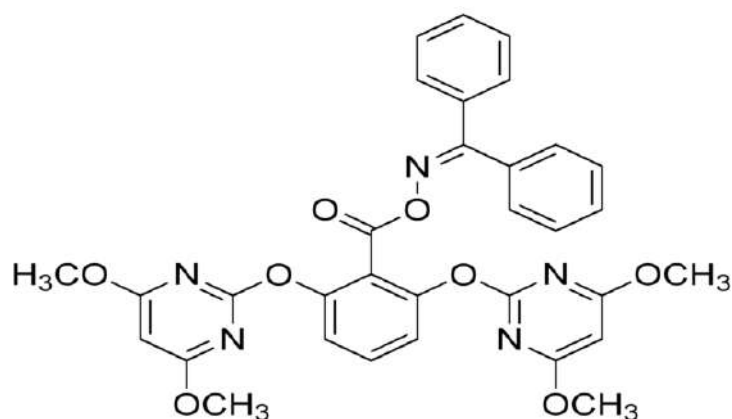
Emergence was almost completed after six days of sowing under each treatment plot. Where young germinated seedling were over crowded, thinning of extra seedlings was done at 10 days after sowing to maintain a uniform intra-row plant population nearly at 3 cm apart. Only thin and weak seedlings were uprooted for thinning of crowded plants without giving jerk to other neighbouring plants.

### **3.9 Application of herbicide**

#### **1. Pyribenzoxim :**

Common name	: Pyribenzoxim
Chemical name(IUPAC)-	: Benzophenone O-[2,6-bis(4,6-dimethoxypyrimidin-2-yloxy)benzoyl]oxime
Active ingredient	: 5% EC
Molecular Formula	: C <sub>32</sub> H <sub>27</sub> N <sub>5</sub> O <sub>8</sub>
Molecular Weight	: 609.59
Time of application	: Post-emergence
Formulation	: EC

Structural formula :



**Pyribenzoxim**

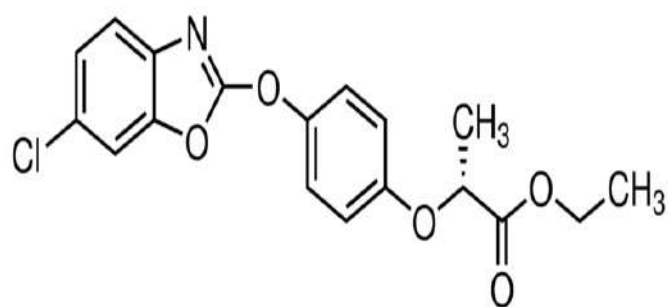
### **Mode of action**

Pyribenzoxim is a broad spectrum, post-emergence herbicide. It inhibits plant amino acid synthesis –acetohydroxyacid synthase (AHAS). It has a low aqueous solubility and is volatile. It indicates that the chemical is not persistent in soil systems. It has a low mammalian toxicity and is a recognized irritant.

### **2. Fenoxaprop –p-ethyl**

Common name	: Fenoxaprop –p-ethyl 6.7%EC
Trade name	: Whip super
Active ingredient	: 6.7%w/w
Formulation	: EC
Chemical name	: ethyl(2R)-2-[4-[(6-chloro-1,3-benzoxazol-2-yl)oxy] phenoxy] propanoate
Molecular Formula:	: C <sub>18</sub> H <sub>16</sub> ClNO <sub>5</sub>
Molecular Weight:	: 361.778 g/mol
Time of application	: Post emergence

Structural formula :



**Fenoxaprop –p-ethyl**

### **Mode of action**

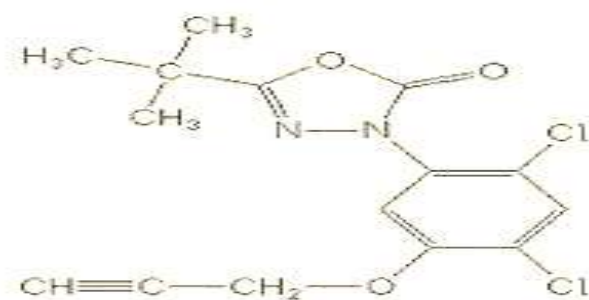
Fenoxaprop-p-ethyl is a selective herbicide for mid- and late-post emergence control of grass weeds. It is absorbed by leaves and stems of plants and is translocated systemically. It predominantly inhibits the synthesis of fatty acids in the meristem tissue of grass weeds. Necrosis at the growing points leads to cessation of growth, chlorosis of the leaves and death within 1 to 2 weeks, depending on environmental conditions

### **3. Oxadiargyl:**

Nature and properties of the herbicide

Common name	: Oxadiargyl
Trade name	: Top star, Adama,
Active ingredient	: 80%
Formulation	: Wettable powder (WP)
Time of application	: Post emergence
Chemical name(IUPAC)	: 5-tert-butyl-3-[2,4-dichloro-5-(prop-2ynyloxy)phenyl]-1,3,4-diazol-2(3H)-one

**Structural formula :**



**Oxadiargyl**

### **Mode of action**

Oxadiargyl is a broad-spectrum herbicide very effective for the control of grasses, sedges and some broad leaf weeds in transplanted rice and it inhibits protoporphyrinogen IX oxidase, the enzyme that converts from Protox to Proto, which finally helps in the weed's necrotic action.

### **3.10 Weed management treatments**

#### **3.10.1 Control plots/ Weedy check plot**

The weeds were allowed to grow along with the crop throughout the crop season in weedy check plots and no control measures were adopted to check the weeds. The weed flora present in the weedy check plots was noted.

#### **3.10.2 Hand weeding**

Hand weeding was done as per treatment manually with the help of Khurpi at 15 and 35 days after sowing as per need of the treatment in weed free plots.

### **3.11 Application of herbicides**

The herbicide spray solution was prepared by mixing the required quantity of herbicide in water at 500 l ha<sup>-1</sup> for each plot. The spray solution for individual plot was prepared separately as per treatment. After completing the spraying of one herbicide, in the respective plots in all three replications, the sprayer was washed thoroughly by detergent and rinsed several times with fresh water, before being used for another treatment. Knapsack sprayer was used for the spraying of herbicidal treatments.

Uniform pressure was maintained to pump out nearly equal quantity of the herbicide uniformly as fine during the spray.

### **3.12. Plant protection**

As the crop was not infested with insect, pest and diseases, hence no any plant protection measure was applied.

### **3.13 Post-emergence application**

Pyribenzoxim was applied as post-emergence application of herbicides in rice and these were sprayed at 15 days after sowing with different dose.

### **3.13 Water management**

Normally, irrigation is needed to rice crop from sowing to harvesting being a water loving crop, so two irrigations were given uniformly to all the plots because of long dry spell coinciding during growth period.

### **3.14 Harvesting**

The crop was harvested when the foliage of the rice plants turned yellowish brown to brown in color. Two border row from each side and 50 cm at both ends of the rows were harvested to eliminate the border effect. The harvested produce of each plot was removed from the field. After this, harvesting of crop from net plot area was done plot wise separately with the help of sickles. The harvested produce of each plot was tied into bundles and tagged with luggage label for demarcation. The plot wise produce was transported to threshing floor and allowed for sun drying for 7 days.

### **3.15 Threshing and winnowing**

After sun drying of each plot on threshing floor the produce was weighed plot wise by using spring balance. After this threshing was done manually by beating with stick for each plot separately. The threshed material of each plot contained seeds and chaffy materials. The chaffs were removed and clean seeds of plot were separated by winnowing with hand fan (supa) manually. The weight of clean seeds obtained for each plot was recorded plot wise with the help of double pan balance.

### 3.16. Observation on weeds

#### 3.16.1 Weed population and relative density

The population of major weeds viz. *Cyperus rotundus*, *Echinochloa colona*, *Digitaria sanguinalis*, *Physalis minima* and *Alternanthera Sessilis* was recorded at before application 15, 30 and 45 DAA by quadrat count method. The quadrat of 0.25 square metre (0.5m x 0.5m) was randomly placed at four places in each plot and then species wise weeds were counted. The values were averaged out and expressed in number m<sup>-2</sup>. The percentage composition of weed flora was estimated from weedy check treatment. The relative density of weeds was worked out as per formula given by Mishra (1968).

$$\text{Relative density (\%)} = \frac{\text{Number of individuals of same species}}{\text{Number of individuals of all species}} \times 100$$

#### 3.16.2 Weed dry weight

The weed biomass from different plots under all the treatment was recorded only before application at 15, 30 and 45 DAA. The associated weeds were collected randomly with 0.25 square meters quadrat from four places in each plot. The weeds were first sun dried and there after kept in paper bags and dried in oven at 60<sup>0</sup>c for 48 hours and dry weight was recorded till constant weight was achieved. Later on, the data on weed biomass was transformed and expressed in gm<sup>-2</sup>.

#### 3.16.3 Weed control efficiency (WCE)

It is the efficiency of treatment to control weeds in comparison to unweeded plot. It was worked out on the basis of formula suggested by Mani et al. (1968). Mathematically, it could be expressed as below.

$$\text{WCE (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where,

WCE = Weed control efficiency (%)

DWC= Dry weight of weeds in control (weedy check) plot

DWT= Dry weight of weeds in treated plot

### 3.16.4 Weed Index

It is percentage reduction in grain yield under particular treatment due to presence of weeds compared to weed free plot. Weed index of each treatment was worked out as per formula given by Gill and Kumar (1969).

$$WI = \frac{YWF-YT}{YWF} \times 100$$

Where,

WI = Weed index

YWF = Grain yield in weed free plot

YT = Grain yield in treated plot

## 3.17 Observation on crop

### 3.17.1 Pre- harvest observations

#### 3.17.2 Phytotoxicity

Herbicide on application to crop field produces certain injury symptoms mainly on weeds and in negligible or under table scale on crop plants in lower doses and induces graded response of growth reduction or death of weeds across plant species. The level of phytotoxicity varies from plant to plant and weeds being most affected. Phytotoxicity to weeds indicates the degree of weed control, whereas phytotoxicity to crop indicates the degree of herbicides selectivity to crop and suggests whether it could safely be used in that crop or not.

#### 3.17.3 Plant population

The number of plants per meter row length was recorded from five randomly selected spots in each plot at 15 DAS and at harvest. After this, the mean value was converted into plant population  $m^{-2}$ .

#### 3.17.4 Plant height (cm)

It was measured from the five marked plants randomly selected from each plot from the ground level up to the tip of the new leaf till flag leaf stage (at 30, 60, 90 DAS and harvest). But after panicle emergence (at harvest), the plant height was measured from base of the plant up to the lower node

of the panicle. The mean plant height was determined by dividing the total plant height by number of plants.

#### **3.17.5 Number of tillers m<sup>-2</sup>**

The number of tillers from five randomly selected plant from each plot was counted at 30, 60, 90 DAS and harvest. Then the number of tillers m<sup>-2</sup> was computed.

#### **3.17.6 Number of leaves m<sup>-2</sup>**

The number of leaves was counted in all the five plant in each plot at 30, 60, 90 DAS and harvest and then the mean number of leaves m<sup>-2</sup> was calculated.

### **3.18 Post- harvest Observations**

#### **3.18.1 Effective tillers m<sup>-2</sup>**

Those tillers which had grain bearing panicle were regarded as fertile tillers. For calculating the number of effective tillers, plant from five randomly selected plant per plot was recorded. Later the mean number of effective tillers was calculated.

#### **3.18.2 Leaf area**

Leaves (five) were removed from the five selected plant of each plot at 30, 60, 90 DAS to measure their leaf area (LA). The LA was measured with the help of leaf area meter and mean was computed.

#### **3.18.3 Dry matter accumulation**

The plant samples were taken at 30, 60, 90 DAS and harvest. Three samples were allowed to sun dry and then dried in an oven at 65°C till constant weight was achieved. After this their dry weight was recorded on electronic balance.

#### **3.18.4 Leaf area index (LAI)**

LAI is the leaf area (A) or assimilatory area over a certain ground area (P). It was worked out at three stages i.e. 30, 60, 90 DAS. Three leaves each from three plants were randomly taken under each treatment mostly from upper, middle portion of the plants. These leaves were kept in poly bags treatment wise and then area of three leaves was recorded on leaf area

meter. Later it was multiplied by number of leaves per plant and there after mean leaf area per plant was determined. Similar procedure was followed for getting the mean leaf area plant<sup>-1</sup> at grain formation stage. Then the leaf area index was calculated by using the formula given by Gardner et al. (1985).

$$LAI = \frac{(A_1 + A_2)/2}{P}$$

Where,

A<sub>1</sub> = Leaf area of 1<sup>st</sup> sampling

A<sub>2</sub> = leaf area of 2<sup>nd</sup> sampling

P = Ground area

### **3.18.5 Length of panicle**

Five panicles from selected each plot were removed at the time of harvesting. The length of each panicle was measured from the base to tip of panicle. Thereafter, mean length of panicle was calculated and presented in centimetre.

### **3.18.6 Grains panicle<sup>-1</sup>**

Five panicles from each plot were selected randomly at the time of harvesting and after this all the filled grains from each panicles was counted manually. Thereafter, mean number of grains panicle<sup>-1</sup> were computed.

### **3.18.6 Chaffy grains panicle<sup>-1</sup>**

All the chuffy grains from five panicle was counted manually. There after mean number of grains panicle<sup>-1</sup> was computed.

### **3.18.7 Sound grains panicle<sup>-1</sup>**

All the sound grains from five panicle was counted manually. There after mean number of sound grains panicle<sup>-1</sup> was computed.

### **3.18.8 Test weight**

From the total produce of each net plot grain samples were drawn and 1000 grains were counted manually. Thereafter, these grains were sun

dried and the weight was recorded on an electronic balance and expressed in g.

### **3.18.9 Grain yield**

After winnowing and cleaning of the produce of each net plot the total produce was weighted separately on a double pan balance. The value obtained was converted into grain yield  $\text{kg ha}^{-1}$  by multiplying with appropriate factor and the grain yield  $\text{kg ha}^{-1}$  was reported.

### **3.18.10 Straw yield ( $\text{kg ha}^{-1}$ )**

It was determined by subtracting the grain yield of a plot from the biological yield of the respective plot. The values so obtained were converted into straw yield  $\text{kg ha}^{-1}$  by multiplying with appropriate factor as done in case of grain yield.

### **3.18.11 Harvest index (HI)**

It is the ratio of economic yield to the biological yield and is expressed in percentage. It was calculated as per the formula proposed by Synder and Carlson (1984).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield}} \times 100$$

## **3.19. Economics**

The cost of production involved in each treatment was determined on the basis of per hectare area. Existing market price of inputs used and outputs obtained were taken into account. The details are given in Appendix I. The net return per hectare was calculated by subtracting the cost of cultivation from the gross monetary returns (value of grain + straw) under a particular treatment while the benefit-cost ratio (profitability) under each treatment was computed as under

$$\text{Benefit: cost ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

### 3.19.1 Cost of cultivation

The cost of cultivation for each treatment is determined on the basis of different inputs used for raising the crop under different treatments on one hectare area basis.

### 3.19.2 Gross monetary returns (GMR)

The values realized from the produce obtained under each treatment was computed on the basis of existing market price of the produce (both grain and straw) as the gross monetary returns(GMR), per hectare under different treatments.

Gross monetary returns = value of grain+value of straw

### 3.19.3 Net monetary returns(NMR)

The net monetary return (NMR) per hectare under each treatment was determined by subtracting the cost of cultivation of a particular treatment from the GMR of the the same treatment.

Net monetary returns= Gross monetary returns-Total cost of cultivation

### 3.19.4 Benefit-cost ratio( B:C)

To estimate the benefits obtained under different treatments for each rupee of expenditure incurred,B:C ratio of each treatments was calculated as below:-

B: C ratio = Gross monetary returns/ Total cost of cultivation.

### 3.20 Statistical analysis

The data obtained for various observations were first tabulated and later subjected to statistical analysis using the techniques of analysis of variance (ANOVA) as suggested by Cochran and Cox (1967).

The skeleton of analysis of variance is given as under:

#### Skeleton of analysis of variance (ANOVA)

S. No.	Source of variation	d. f.	S. S.	M. S. S.	Fcal	
					5%	1%
1.	Replications	(r-1)				
2.	Treatment	(t-1)				
3.	Error	(r-1)(t-1)				
	Total	(rt-1)				

Where,

r = number of replications

t = number of treatments

### 3.20.1 Standard errors and critical differences

The standard error of mean ( $SE_{m\pm}$ ) was calculated for each observation, either it is significant or not, but the critical difference (C.D.) was calculated only for significant difference. The  $SE_{m\pm}$  and C.D. at 5% was given in each table of results. To test the significant differences among the treatment means, the following formulas were used.

$$SE_{m\pm} = \sqrt{\frac{E_{ms}}{r}}$$

$$S. Ed. = S. Em \times \sqrt{2}$$

$$CD = SEd \times t_{(0.05)}(edf)$$

Where,

S.  $Em_{\pm}$  = standard error of treatment means

S.  $Ed_{\pm}$  = standard error of difference between treatment means

C. D. = critical difference

r = number of replications

edf = error degree of freedom

## RESULTS

The present chapter deals with the findings of the investigation conducted during *kharif* 2017. The observations recorded on weeds, growth parameters, yield attributes, yields and economics of rice under different weed control treatments were statistically analyzed. The results obtained are presented through tables and Fig. under appropriate headings.

### 4.1 Studies on weeds

#### 4.1.1 Weed flora of rice

Data on species wise density ( $m^{-2}$ ) of weeds recorded in weedy check plots before application at 15, 30, and 45 DAA and relative density (%) are presented in Table 4.1 and fig. 4.1(a). It is obvious from the data that there was predominance of monocot and dicot weeds in weedy check plots of rice during *kharif* 2017.

**Table 4.1: Species wise weed density before application at 15, 30 and 45 DAA and relative density in weedy check plots**

S. No	Weed flora	Density ( $m^{-2}$ )				Mean	Relative density (%)
		BA	15 DAA	30 DAA	45 DAA		
<b>A</b>	<b>Monocot weeds</b>						
1.	<i>Echinochloa colona</i>	58.10	58.52	60.08	58.9	59.15	17.07
2.	<i>Cyperus rotundus</i>	62.00	64.00	66.00	64.00	64.00	18.50
3	<i>Digitaria sanguinalis</i>	74.00	76.00	76.95	75.65	75.65	21.86
	<b>Subtotal</b>					198.55	
<b>B</b>	<b>Dicot weeds</b>						
4.	<i>Alternanthera Sessilis</i>	70.89	71.58	77.42	73.38	73.31	21.19
5.	<i>Physalis minima</i>	72.83	73.93	75.18	73.98	73.98	21.38
	<b>Subtotal</b>					147.36	
	<b>Total</b>					345.91	100.00

Among the weeds, *Digitaria sanguinalis* was the most dominant weed (74.00, 76.00, 76.95, 75.65 m<sup>-2</sup>) before application at 15, 30, and 45 DAA and mean relative density (21.86%) followed by *Physalis minima*, *Alternanthera sessilis*, and *Cyperus rotundus*. The dominance of *Echinochloa colona* was least among all the weed species.

## 4.2 Effect on weed density

The data recorded on density of different weeds (viz., *Echinochloa colona*, *Cyperus rotundus*, *Digitaria sanguinalis*, *Alternanthera sessilis* and *Physalis minima*) as influenced by different weed control treatments before application at 15, 30 and 45 DAA are presented in Table 4.2 (a), (b) and (c) and Fig. 4.2 (a), (b), (c) (d) and (e). The comparison among treatment means were made on transformed values.

### 4.2.1 *Echinochloa colona*

The density of *Echinochloa colona* differed significantly at 15, 30 and 45 DAA due to different weed control measures. The density of *Echinochloa colona* was maximum (7.65, 7.69 and 7.78 m<sup>-2</sup>) under weedy check plots at 15, 30 and 45 DAA. Post emergence application of pyribenzoxim at different dose caused significant lower density over weedy check plots. However, the efficacy of pyribenzoxim was further improved with the corresponding increase in rates of application being the higher when it was applied at (25, 30, 35 and 60 gha<sup>-1</sup>) but hand weeding twice (15 and 35 DAS) at both stages were most effective (1.84, 1.68 and 1.58 m<sup>-2</sup>). On the other hand the check herbicides, fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> and oxadiargyl 100gha<sup>-1</sup> were proved less effective than the higher doses of pyribenzoxim (60 gh<sup>-1</sup>) in controlling this weed.

**Table 4.2(a): Effect of different treatments on weed density of *Echinochloa colona***

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Density (m <sup>-2</sup> )			
			<i>Echinochloa colona</i>			
			BA	15DAA	30DAA	45DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	7.75 (59.58)	4.18 (17.00)	4.11 (16.42)	3.85 (14.33)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	7.77 (59.83)	3.83 (14.17)	3.81 (14.00)	3.53 (12.00)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	7.77 (59.92)	3.79 (13.92)	3.76 (13.67)	3.49 (11.75)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	7.70 (59.83)	2.85 (7.67)	2.74 (7.00)	2.56 (6.08)
T <sub>5</sub> .	Fenoxaprop p-ethyl 6.7% EC	56.95	7.70 (58.75)	3.85 (14.33)	3.76 (13.67)	3.72 (13.33)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	7.77 (59.92)	3.74 (13.50)	3.64 (12.75)	3.52 (11.92)
T <sub>7</sub> .	Hand weeding twice	15 and 35 DAS	7.80 (60.33)	1.84 (2.92)	1.68 (2.42)	1.58 (2.00)
T <sub>8</sub> .	Weedy check	-	7.75 (59.50)	7.65 (58.00)	7.69 (58.58)	7.78 (60.08)
	<b>SEm±</b>		0.02	0.10	0.11	0.09
	<b>CD at 5%</b>		NS	0.31	0.36	0.27

#### 4.2:2 *Digitaria sanguinalis*

The density of *Digitaria sanguinalis* at 15, 30 and 45 DAA under different weed control treatments are given in Table 4.2(b) and fig. 4.2 (b). It is evident from the data that the different weed control treatments appreciably reduced the density of *Digitaria sanguinalis* at 15, 30 and 45 DAA as compared to weedy check(8.63,8.75,8.80 m<sup>-2</sup>). Pyribenzoxim as post emergence @ 60 gha<sup>-1</sup> showed its superiority in comparison to the other treatments in reducing the density of *Digitaria sanguinalis* (4.26, 4.12 and 3.81 m<sup>-2</sup>) at 15, 30 and 45 DAA but at harvest its value was at par with pyribenzoxim @ 35 g ha<sup>-1</sup> (4.98,4.84 and 4.66 m<sup>-2</sup>) respectively. The least density was observed with hand weeding twice (1.78, 1.72 and 1.58m<sup>-2</sup>).

#### 4.2.3 *Cyperus rotundus*.

The density of *Cyperus rotundus* at 15, 30 and 45 DAA under different weed control treatments are given in Table 4.2(b) and Fig. 4.2 (c). It is evident from the data that the different weed control treatments appreciably reduced the density of *Cyperus rotundus* at 15, 30 and 45 DAA as compared to weedy check(7.91,8.03,8.15m<sup>-2</sup>). Pyribenzoxim as post emergence @ 60 gha<sup>-1</sup> showed its superiority in comparison to the other treatments in reducing the density of *Cyperus rotundus* (3.01, 2.92 and 2.79 m<sup>-2</sup>) at 15, 30 and 45 DAA but at harvest its value was significantly with pyribenzoxim @ 35 gha<sup>-1</sup> (3.82, 3.71 and 3.50 m<sup>-2</sup>) respectively. The least density was observed with hand weeding twice (1.74, 1.75 and 1.44 m<sup>-2</sup>).

**Table 4.2(b): Effect of different treatments on density of *Digitaria senguinalis* and *Cyperus rotundus* in rice**

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Density (m <sup>-2</sup> )							
			<i>Digitaria senguinalis</i>				<i>Cyperus rotundus</i>			
			BA	15 DAA	30 DAA	45 DAA	BA	15 DAA	30 DAA	45 DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	8.40 (70.00)	5.15 (26.00)	5.06 (25.08)	4.85 (23.00)	7.72 (59.08)	4.11 (16.42)	3.98 (15.33)	3.89 (14.67)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	8.40 (70.00)	4.99 (24.42)	4.85 (23.08)	4.67 (21.33)	7.68 (58.50)	3.84 (14.25)	3.73 (13.42)	3.55 (12.00)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	8.42 (70.33)	4.98 (24.33)	4.84 (22.92)	4.66 (21.25)	7.66 (58.25)	3.82 (14.17)	3.71 (13.25)	3.50 (11.83)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	8.38 (69.67)	4.26 (17.67)	4.12 (16.50)	3.81 (14.00)	7.65 (58.00)	3.01 (8.58)	2.92 (8.08)	2.79 (7.33)
T <sub>5</sub> .	Fenoxaprop-p-ethyl 6.7% EC	56.95	8.41 (70.17)	4.91 (23.67)	4.75 (22.08)	4.55 (20.25)	7.68 (54.50)	4.00 (15.50)	3.89 (14.67)	3.72 (13.33)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	8.40 (70.00)	4.85 (23.08)	4.71 (21.67)	4.52 (19.92)	7.66 (58.25)	3.71 (13.25)	2.66 (12.93)	3.54 (12.00)
T <sub>7</sub> .	Hand weeding twice	15 and 35 DAS	8.40 (70.08)	1.78 (2.67)	1.72 (2.50)	1.58 (2.00)	7.76 (59.75)	1.74 (2.52)	1.75 (2.58)	1.44 (1.58)
T <sub>8</sub> .	Weedy check	-	8.41 (70.17)	8.63 (74.00)	8.75 (76.00)	8.80 (77.00)	7.75 (59.58)	7.91 (62.00)	8.03 (64.00)	8.15 (66.00)
	<b>SEm±</b>		0.01	0.08	0.09	0.05	0.01	0.09	0.07	0.09
	<b>CD at 5%</b>		NS	0.26	0.27	0.16	NS	0.27	0.21	0.29

#### 4.2.4 *Alternanthera sessilis*

The density of *Alternanthera sessilis* as affected by different weed control treatments at 15, 30 and 45 DAA are given in Table 4.2(c) and Fig. 4.2 (d). The data clearly indicates that the weed control treatments caused significant reduction in the density of this weed at 15, 30 and 45 DAA. The density was maximum (8.40, 8.49 and 8.83 m<sup>-2</sup>) at 15, 30 and 45 DAA in weedy check plots respectively slightly significant from fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> (8.38, 8.44 and 8.75m<sup>-2</sup>). It was reduced appreciably with the application of pyribenzoxim as post emergence @ 60 gha<sup>-1</sup>(3.41,3.02 and 2.95m<sup>-2</sup>) and this dose was found at par at 15 DAA and significant at 30 and 45 DAA with pyribenzoxim @ 35 gha<sup>-1</sup> (4.31, 4.26 and 4.10m<sup>-2</sup>) but more effective than its lower dose @ 25 and 30 gha<sup>-1</sup> and check herbicides oxadiargyl 100 gha<sup>-1</sup>, the lowest density of this weed was noticed under hand weeding twice (2.14, 2.12 and 1.58m<sup>-2</sup>).

#### 4.2.6 *Physalis minima*

The density of *Physalis minima* as affected by different weed control treatments at 15, 30 and 45 DAA are given in Table 4.2(c) and Fig. 4.2 (e). The data clearly indicates that the weed control treatments caused significant reduction in the density of this weed at 15, 30 and 45 DAA. The density was maximum (8.40, 8.63 and 8.70 m<sup>-2</sup>) at 15, 30 and 45 DAA weedy check plots respectively slightly significant from fenoxaprop-p-ethyl 56.95 g ha<sup>-1</sup>(8.46, 8.57 and 8.61m<sup>-2</sup>). It was reduced appreciably with the application of pyribenzoxim as post emergence @ 60 gha<sup>-1</sup> (2.96,2.74 and 2.59m<sup>-2</sup>) and it was also reduced in pyribenzoxim @ 35 gha<sup>-1</sup>(4.29, 4.13 and 4.02m<sup>-2</sup>) this dose was found at par at 15 DAA and significant at 30 and 45 DAA with pyribenzoxim @ 30 gha<sup>-1</sup> (4.31, 4.17 and 4.06m<sup>-2</sup>) but more effective than its lower dose @ 25 gha<sup>-1</sup> and check herbicides oxadiargyl 100 gha<sup>-1</sup>, the lowest density of this weed was noticed under hand weeding twice (2.20, 1.95 and 1.79m<sup>-2</sup>).

**Table 4.2(c): Effect of different treatments on density of *Alternanthera sessilis* and *Physalis minima* in rice**

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Density (m <sup>-2</sup> )							
			<i>Alternanthera sessilis</i>				<i>Physalis minima</i>			
			BA	BA	15DAA	45DAA	BA	15DAA	30DAA	45DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	8.10 (65.08)	8.31 (58.58)	4.65 (21.08)	4.38 (18.67)	8.31 (58.58)	4.65 (21.08)	4.40 (18.92)	4.30 (18.08)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	8.41 (70.25)	8.40 (70.08)	4.31 (18.08)	4.13 (16.58)	8.40 (70.08)	4.31 (18.08)	4.17 (16.92)	4.06 (16.00)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	8.48 (71.43)	8.36 (69.43)	4.29 (17.92)	4.10 (16.33)	8.36 (69.43)	4.29 (17.92)	4.13 (16.58)	4.02 (15.67)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	8.56 (72.83)	8.31 (68.58)	2.96 (8.25)	2.95 (8.25)	8.31 (68.58)	2.96 (8.25)	2.74 (7.08)	2.59 (6.33)
T <sub>5</sub> .	Fenoxaprop p-ethyl 6.7% EC	56.95	8.58 (73.08)	8.36 (69.33)	8.46 (71.00)	8.75 (76.08)	8.36 (69.33)	8.46 (71.00)	8.57 (72.92)	8.61 (73.67)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	8.58 (73.08)	8.25 (67.58)	4.16 (16.83)	3.93 (15.00)	8.25 (67.58)	4.16 (16.83)	4.05 (15.92)	3.70 (13.25)
T <sub>7</sub> .	Hand Weeding twice	15 and 35 DAS	8.46 (71.08)	8.34 (69.08)	2.20 (4.33)	1.58 (2.00)	8.34 (69.08)	2.20 (4.33)	1.95 (3.33)	1.79 (2.77)
T <sub>8</sub> .	Weedy check	-	8.53 (72.25)	8.30 (78.42)	8.40 (72.83)	8.83 (77.42)	8.30 (78.42)	8.40 (72.83)	8.63 (74.00)	8.70 (75.25)
	<b>SEm±</b>		0.01	0.01	0.05	0.09	0.01	0.05	0.12	0.11
	<b>CD at 5%</b>		NS	NS	0.17	0.28	NS	0.17	0.38	0.35

### 4.3 Dry weight of weeds

Dry matter accumulation by weeds per unit area is an evidence of weed growth under particular treatment. The observations on dry weight of weeds were taken before application at 15, 30 and 45 DAA. The associated weeds with rice were separated species wise from each quadrat and their dry weight was noted treatment wise after sun drying and then dried in oven at 65 °C for 48 hours till constant weight was achieved. The data were then presented after square root transformation. The weed species showed different response as per given treatment.

#### 4.3.1 *Echinochloa colona*

The dry weight of *Echinochloa colona* changed much affected due to different weed control treatments at 15, 30, and 45 DAA. Table 4.3(a) Fig. 4.3 (a). It was maximum (6.27, 7.70 and 8.55 g m<sup>-2</sup>) under weedy check plots at 15, 30, and 45 DAA. Its dry weight was reduced identically when control treatments were applied in different post emergence application of pyribenzoxim @ 60 gha<sup>-1</sup> was found more effective in reducing the dry weight (2.39, 2.70 and 2.75 g m<sup>-2</sup>) of this weed. However, efficacy of the herbicide was increased with corresponding increase in its doses. The dry weight of this weed was lowest under hand weeding twice (1.45, 1.66 and 1.28 g m<sup>-2</sup>).

#### 4.3.2 *Digitaria sanguinalis*

The data on dry weight of *Digitaria sanguinalis* at 15, 30, and 45 DAA under various weed control treatments are presented in Table 4.3(b) and 4.3 (b). It is evident from the data that different weed control treatments had significantly lowered the dry weight of *Digitaria sanguinalis* at 15, 30 and 45 DAA as compared to weedy check plots. But the reduction was markedly more with the highest dose of pyribenzoxim as post emergence @ 60 gha<sup>-1</sup> (3.35, 3.53 and 3.46 g m<sup>-2</sup>) at 15, 30 and 45 DAA. Though, hand weeding twice had the lowest dry weight of this weed (1.45, 1.46 and 1.53 g m<sup>-2</sup>).

### 4.3.3 *Cyperus rotundus*

Data on dry weight of *Cyperus rotundus* at 15, 30, and 45 DAA under different weed control treatments are given in Table 4.3(b) and fig. 4.3 (c). It is obvious from the data that different treatments had significantly reduced dry weight of *Cyperus rotundus* at 15, 30, and 45 DAA over weedy check. The dry weight of this weed was maximum (6.56, 7.95 and 9.12 g m<sup>-2</sup>) under weedy check plots where no any control measure was adopted at all intervals. But reduction was more pronounced with as post emergence @ 60 gha<sup>-1</sup> (2.56, 2.98 and 3.35 g m<sup>-2</sup>) at 15, 30 and 45 DAA as compared to its lower dose and check herbicides fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> and oxadiargyl 100 gha<sup>-1</sup>. The lowest dry weight of this weed was noted under hand weeding twice (1.62, 1.79 and 1.61 g m<sup>-2</sup>).

**Table 4.3 (a) Effect of different treatments on weed dry weight of *Echinochloa colona***

T.No.	Treatments	Dose (g a.i./ha)	Dry weight (g m <sup>-2</sup> )			
			<i>Echinochloa colona</i>			
			BA	15DAA	30DAA	45DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	4.97 (24.19)	3.54 (12.14)	4.07 (16.42)	4.07 (16.12)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	4.99 (24.36)	3.23 (10.08)	3.85 (14.31)	3.81 (14.01)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	4.97 (24.22)	3.21 (9.86)	3.76 (13.97)	3.78 (13.81)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	5 (24.51)	2.39 (5.25)	2.70 (6.89)	2.75 (7.11)
T <sub>5</sub> .	Fenoxaprop p-ethyl 6.7% EC	56.95	5.01 (24.60)	3.21 (9.79)	3.72 (13.38)	3.89 (14.66)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	5.0 (24.50)	3.06 (8.88)	3.55 (12.13)	3.69 (13.10)
T <sub>7</sub> .	Hand weeding twice	15 and 35 DAS	4.97 (24.22)	1.45 (1.60)	1.66 (2.42)	1.28 (1.13)
T <sub>8</sub> .	Weedy check	-	4.98 (24.33)	6.27 (38.80)	7.70 (58.87)	8.55 (72.93)
	SEm±		0.02	0.08	0.11	0.06
	CD at 5%		0.08	0.25	0.35	0.20

**Table 4.3(b) Effect of different treatments on weed dry weight of *Cyperus rotundus* and *Digitaria sanguinalis***

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Dry weight (g m <sup>-2</sup> )							
			<i>Cyperus rotundus</i>				<i>Digitaria sanguinalis</i>			
			BA	15DAA	30DAA	45DAA	BA	15DAA	30DAA	45DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	7.72 (59.08)	3.50 (11.79)	4.00 (15.57)	4.25 (17.67)	6.36 (39.99)	4.19 (17.06)	4.74 (22.05)	4.73 (21.88)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	7.68 (58.50)	3.27 (10.21)	3.79 (13.95)	4.05 (15.95)	6.39 (40.40)	3.95 (15.14)	4.52 (20.09)	4.41 (18.97)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	7.66 (58.25)	3.22 (9.87)	3.76 (13.72)	4.01 (15.71)	6.44 (41.03)	3.91 (14.91)	4.51 (19.88)	4.38 (18.77)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	7.65 (58.00)	2.56 (6.10)	2.98 (8.45)	3.35 (10.12)	6.43 (40.82)	3.35 (10.79)	3.53 (12.12)	3.46 (11.48)
T <sub>5</sub> .	Fenoxaprop-p-ethyl 6.7% EC	56.95	7.68 (58.50)	3.41 (11.13)	3.91 (14.85)	4.14 (16.70)	6.45 (41.14)	3.95 (15.13)	2.73 (7.02)	2.91 (7.94)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	7.66 (58.25)	3.22 (9.89)	3.69 (13.16)	3.95 (15.15)	3.36 (40.00)	3.83 (14.20)	3.94 (15.10)	4.11 (16.40)
T <sub>7</sub> .	Hand weeding twice	15 and 35 DAS	7.76 (59.75)	1.62 (2.20)	1.79 (2.70)	1.61 (2.10)	6.38 (40.20)	1.45 (1.59)	1.46 (1.70)	1.53 (1.84)
T <sub>8</sub> .	Weedy check	-	7.75 (59.58)	6.56 (45.51)	7.95 (62.70)	9.12 (82.63)	6.43 (40.88)	6.54 (42.33)	7.79 (60.16)	7.91 (62.03)
	<b>Sem+=</b>		0.01	0.13	0.08	0.08	0.018	0.08	0.15	0.07
	<b>CD at 5%</b>		0.03	0.39	0.26	0.24	0.05	0.24	0.47	0.22

#### **4.3.4 *Alternanthera sessilis***

Data on dry weight of *Alternanthera sessilis* at 15, 30 and 45 DAA under various treatments are depicted in Table 4.3(c) and Fig. 4.3 (d). It is obvious from the data that weed control treatments had significantly reduced the dry weight of *Alternanthera sessilis* at all intervals. The dry weight was maximum (7.82, 8.96 and 9.63 g m<sup>-2</sup>) under weedy check plots and respectively slightly significantly from fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup>(7.62, 8.79 and 8.83 g m<sup>-2</sup>). Significant reduction in the dry weight was noted under varied doses of pyribenzoxim as post emergence @ 25, 30 and 60 gha<sup>-1</sup>, but the dry weight was more with 25 gha<sup>-1</sup> and reduced with its higher dose 60 gha<sup>-1</sup> (3.15, 3.14 and 3.26 g m<sup>-2</sup>). The lowest values of dry weight of this weed were observed under hand weeding twice at all the intervals (1.91, 1.86 and 1.73 g m<sup>-2</sup>).

#### **4.3.5 *Physalis minima***

Data on dry weight of *Physalis minima* at 15, 30 and 45 DAA under various treatments are depicted in Table 4.3(c) and fig. 4.3 (e). It is obvious from the data that weed control treatments had significantly reduced the dry weight of *Physalis minima* at all the intervals. The dry weight was maximum (7.82, 8.92 and 9.34 g m<sup>-2</sup>) under weedy check plots and respectively slightly significantly fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup>(7.61, 7.60 and 9.07 g m<sup>-2</sup>). Significant reduction in the dry weight was noted under varied doses of pyribenzoxim as post emergence @ 25, 30 and 60 gha<sup>-1</sup>, but the dry weight was more with 25 gha<sup>-1</sup> and reduced with its higher dose 60 gha<sup>-1</sup> (3.39, 3.55 and 3.63 g m<sup>-2</sup>). The lowest values of dry weight of this weed were observed under hand weeding twice at all the intervals (1.96, 1.85 and 1.71 g m<sup>-2</sup>).

**Table 4.3(c) Effect of different treatments on weed Dry weight of *Alternanthera sessilis* and *Physalis minima***

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Weed Dry weight (m <sup>-2</sup> )							
			<i>Alternanthera sessilis</i>				<i>Physalis minima</i>			
			BA	15DAA	30DAA	45DAA	BA	15DAA	30DAA	45DAA
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	5.98 (35.28)	4.32 (18.19)	4.62 (20.88)	4.79 (22.46)	6.11 (36.85)	4.56 (20.34)	4.83 (22.84)	4.99 (24.44)
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	5.98 (35.31)	4.07 (16.19)	4.39 (18.78)	4.56 (20.33)	6.13 (37.03)	4.37 (18.58)	4.56 (20.31)	4.77 (21.26)
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	5.93 (34.64)	4.04 (15.94)	4.36 (18.51)	4.55 (20.18)	6.05 (36.15)	4.32 (18.33)	4.53 (20.02)	4.75 (22.07)
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	5.94 (34.73)	3.15 (9.47)	3.14 (9.40)	3.26 (10.12)	6.07 (36.63)	3.39 (11.00)	3.55 (12.16)	3.63 (12.69)
T <sub>5</sub> .	Fenoxaprop p-ethyl 6.7% EC	56.95	5.83 (38.47)	7.62 (57.57)	8.79 (76.77)	8.83 (77.48)	6.12 (37.00)	7.61 (54.46)	7.60 (57.20)	9.07 (81.70)
T <sub>6</sub> .	Oxadiargyl 80% WP	100	5.83 (33.53)	3.84 (14.26)	4.10 (16.35)	4.31 (18.13)	6.11 (36.85)	3.93 (14.91)	4.16 (16.81)	4.54 (20.15)
T <sub>7</sub> .	Hand weeding twice	15 and 35 DAS	5.85 (33.76)	1.91 (3.21)	1.86 (3.16)	1.73 (2.50)	6.05 (36.10)	1.96 (3.33)	1.85 (3.13)	1.71 (2.43)
T <sub>8</sub> .	Weedy check	-	5.89 (34.21)	7.82 (60.69)	8.96 (79.82)	9.63 (92.26)	6.03 (35.86)	7.82 (60.60)	8.92 (79.01)	9.34 (86.65)
	SEm±		0.01	0.07	0.09	0.05	0.06	0.09	0.10	0.06
	CD at 5%		NS	0.22	0.28	0.16	0.18	0.28	0.30	0.20

#### 4.4.1 Weed control efficiency

Weed control efficiency (WCE) was computed on the basis of weed biomass recorded under weedy check and other treatments at 30 DAS has been shown in Table 4.4(a) and Fig 4.4. The weed control efficiency was ranged from (71.39 to 96.37%) over weed check plot. The higher weed control efficiency was noticed in plots receiving pyribenzoxim @ 25, 30, 35 and 60 gha<sup>-1</sup>, as compared to check herbicide fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> and oxadiargyl 100 gha<sup>-1</sup>. However, all the herbicidal doses suppressed weeds, but magnitude of suppression was higher in pyribenzoxim as post emergence @ 60 gha<sup>-1</sup> (85.50% at 30 DAS repectively) followed by pyribenzoxim @ 35 gha<sup>-1</sup> (79.31% at 30 DAS respectively). Hand weeding twice at 15 and 35 DAS (96.37%),respectively was superior amongst all weed control treatments in reducing weed growth.

#### 4.4.2 Weed index

The weed index under different weed control treatments was worked out on the basis of grain yield produced under the treatments and hand weeding twice. The related data are given in Table 4.4.(a) and graphically represented through Fig. 4.4. The result indicates that in general weed index was minimum (0.00 %) with hand weeding twice which gradually increase with the application of pyribenzoxim @ 30 gha<sup>-1</sup> (24.18 %). The index was maximum (43.00 %) under weedy check plots.

**Table 4.4: Weed control efficiency of different weed control treatments at 30DAA and weed index**

	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Weed biomass	WCE (%)	Weed index (%)
T <sub>1</sub> .	Pyribenzoxim 500 ml/ha	25	97.92	71.39	35.25
T <sub>2</sub> .	Pyribenzoxim 600 ml/ha	30	86.65	76.85	24.18
T <sub>3</sub> .	Pyribenzoxim 700 ml/ha	35	85.38	79.31	23.50
T <sub>4</sub> .	Pyribenzoxim 1200 ml/ha	60	48.50	85.50	23.72
T <sub>5</sub> .	Fenoxaprop-p-ethyl 6.7% EC	56.95	192.08	50.60	24.11
T <sub>6</sub> .	Oxadiargyl 80% WP	100	80.35	78.40	27.50
T <sub>7</sub> .	Hand weeding twice	15 and 35DAS	15.83	96.37	0.00
T <sub>8</sub> .	Weedy check		343.00	71.39	43.00

## 4.5 Studies on crop:-

### 4.5.1 Plant population

Data recorded on plant population at 15 DAS and at harvest under different treatments are given in (Table 4.5). Plant population at 15 DAS and harvest was not affected due to weed control treatments and it was practically similar in all the treatments including hand weeding and weedy check plots where no herbicides were applied, suggesting that post-emergence application of pyribenzoxim between (25 to 60 gha<sup>-1</sup>) and check herbicides fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> and oxadiargyl 100 gha<sup>-1</sup> did not cause any adverse effect on the crop density.

**Table 4.5: Effect of different weed control treatments on plant population**

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Plant population ( m <sup>-2</sup> )	
			15 DAS	Harvest
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	131.10	129.56
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	131.09	129.61
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	131.05	129.70
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	131.02	129.66
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56.95	131.11	129.42
T <sub>6</sub>	Oxadiargyl 80% WP	100	131.10	129.40
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	131.17	129.73
T <sub>8</sub>	Weedy check	-	131.06	129.02
SEM±			0.20	0.24
CD at 5%			NS	NS

### 4.5.2 Plant height

Data on plant height recorded at 30, 60 and 90 DAS and harvest stages under different weed control treatments are presented in (Table 4.6) In general, the plant height was minimum under all the treatments during early period of crop growth, which was increased with time and being the maximum

at 90 DAS, thereafter, there was marginal decline in plant height under all the treatments at harvest. However, the rate of increase in plant height was higher between 30 and 60 DAS. At 30 DAS. The plant height was affected significantly under different treatments. Plant height was maximum (52.89 cm) under hand weeding twice (15 and 35 DAS) followed by pyribenzoxim as post emergence @30 gha<sup>-1</sup> (52.59cm) and 35 gha<sup>-1</sup>(52.53 cm) being at par amongst each other and significantly superior over remaining treatments.

**Table 4.6: Effect of different weed control treatments on plant height**

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Plant height (cm)			
			30 DAS	60 DAS	90 DAS	Harvest
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	14.60	33.69	51.46	51.36
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	15.32	34.73	52.59	52.42
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	15.28	34.69	52.53	52.38
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	15.16	34.58	52.42	52.31
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56.95	15.11	34.50	52.38	52.29
T <sub>6</sub>	Oxadiargyl 80% WP	100	15.8	34.47	52.34	52.26
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	15.77	34.93	52.89	52.71
T <sub>8</sub>	Weedy check	-	13.85	32.74	50.98	50.49
SEm±			0.434	0.561	0.399	0.398
CD at 5%			1.318	1.69	1.20	1.20

The lowest plant height (50.98 cm) was recorded in weedy check. On the other hand, the check herbicides, fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> and oxadiargyl 100 gha<sup>-1</sup> proved significant to weedy check plot but at 60 days growth stage, remarkable variation in plant height was recorded. Plant height was maximum under hand weeding twice at 15 and 35 DAS (52.89 cm), which was significantly superior to weedy check and all herbicides were comparable to each other. Application of pyribenzoxim @ 30 gha<sup>-1</sup> was

caused marginal increase as compared to higher dose, but it was higher than fenoxaprop-p-ethyl and oxadiargyl at 90DAS and harvest different weed control treatment exhibited almost similar trend in plant height as observed at 30 DAS.

#### 4.5.3 Number of tillers

**Table 4.7: Effect of different weed control treatments on number of tillers**

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Number of tillers (m <sup>-2</sup> )			
			30 DAS	60 DAS	90 DAS	Harvest
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	289.21	385.00	384.89	384.61
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	301.30	384.48	384.42	384.30
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	293.44	376.79	376.73	376.59
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	291.87	362.07	362.03	361.08
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56.95	290.86	376.21	376.11	375.87
T <sub>6</sub>	Oxadiargyl 80% WP	100	289.19	379.46	379.40	379.19
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	315.96	502.60	502.56	502.34
T <sub>8</sub>	Weedy check	-	283.09	332.49	332.39	332.27
SEm±			11.87	6.13	9.66	7.56
CD at 5%			35.94	18.56	28.98	23.67

The number of tillers m<sup>-2</sup> was minimum at 30 DAS which increased with time and attained the maximum value at 90 DAS and declined marginally at harvest under all the treatments (Table 4.7).

Different weed control treatments caused remarkable variations in the number of tillers m<sup>-2</sup> at 30, 60 and 90 DAS and harvest. Weedy check plots have the minimum number of tillers m<sup>-2</sup> (283.09, 332.49, 332.39, 332.27 m<sup>-2</sup>), which increased appreciably at all the growth intervals as the plots received weed control treatments. Application of pyribenzoxim as post emergence @ 30 gha<sup>-1</sup> resulted in markedly higher number of tillers m<sup>-2</sup> (301.30, 384.48,

384.42, 384.30 m<sup>-2</sup>) over rest of the the doses (25,35 and 60 gha<sup>-1</sup>) and check herbicide fenoxaprop-p-ethyl and oxadiargyl all growth intervals. However, the number of tillers m<sup>-2</sup> were maximum under hand weeding twice at 30, 60, 90 DAS and harvest (315.96, 502.60, 502.56, 502.34g m<sup>-2</sup>).

#### **4.5.4 Dry matter accumulation**

Data on average dry matter accumulation of rice as affected by various weeds control treatments at different time interval are presented in (Table 4.8) and graphically illustrated through the (Fig. 4.5). It is evident from the data that average dry matter accumulation gradually increased with the advancement in the growth stages up to maturity under all treatments. The rate of increase in dry matter accumulation was most rapid during 30 to 60 DAS as compare to 60 to 90 DAS and harvest.

Different weed control treatments caused remarkable variations in the quantity of dry matter accumulation at 30, 60 and 90 DAS and harvest. Weedy check plots have the minimum quantity of dry matter production (6.26, 28.83, 76.69 and 77.89 gm<sup>-2</sup> ) which increased appreciably at all the growth intervals as the plots received weed control treatments. Application of post emergence application of pyribenzoxim @ 30 gha<sup>-1</sup> resulted in markedly higher dry matter accumulation (7.69, 31.94, 91.32 and 93.26 g m<sup>-2</sup>) and in pyribenzoxim @ 35 gha<sup>-1</sup> (7.63, 31.87, 91.25 and 93.21 g m<sup>-2</sup>) which values of dry matter accumulation were at par from pyribenzoxim @ 30 gha<sup>-1</sup> and superior rest of the doses (25 and 60 gha<sup>-1</sup>) and check herbicide oxadiargyl and fenoxaprop-p-ethyl at all growth intervals. However, the dry matter accumulations were maximum under hand weeding (7.46, 34.53, 98.81, and 100.15 g m<sup>-2</sup>) at 15 and 35 DAS.

**Table 4.8: Dry matter accumulation at different growth intervals of rice as influenced by different treatments**

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Dry matter accumulation (gm <sup>-2</sup> )			
			30 DAS	60 DAS	90 DAS	Harvest
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	6.91	31.60	89.26	91.10
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	7.69	31.94	91.32	93.26
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	7.63	31.87	91.25	93.21
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	7.33	31.76	91.16	93.02
T5	Fenoxaprop-p-ethyl 6.7% EC	56.95	7.27	31.53	90.91	92.93
T6	Oxadiargyl 80% WP	100	7.24	31.48	90.86	92.88
T7	Hand weeding twice	15 and 35 DAS	7.46	34.53	98.81	100.15
T <sub>8</sub>	Weedy check	-	6.26	28.83	76.69	77.89
SEm±			0.146	0.074	0.247	0.399
CD at 5%			0.44	0.22	0.74	1.20

#### 4.5.5 Leaf area index

Leaf area index is the ultimate expression of photosynthetic activity of the plant, which may have a great bearing on growth and yield parameters during development phase of the crop. The data in relation to LAI as influenced by different treatments are given in (Table 4.9) and (fig. 4.6). The data indicates that the LAI was maximum at 30 DAS (2.05) with hand weeding twice and minimum (1.33) under weedy check plot. The value of LAI under pyribenzoxim as post emergence @ 30 gha<sup>-1</sup> had significantly higher (1.75) and it was at par with pyribenzoxim @ 35 gha<sup>-1</sup> (1.70) and other application @ 25 and 60 gha<sup>-1</sup> (1.36 and 1.42). Leaf area index under check herbicides fenoxaprop-p-ethyl 56.95 gha<sup>-1</sup> (1.39) and oxadiargyl 100 gha<sup>-1</sup> (1.35) treatments were not marked and same trend was followed at 60 and 90 DAS.

**Table 4.9: Leaf area index (LAI) at different time interval of rice as affected by various treatments**

T.No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Leaf area index (LAI)		
			30DAS	60DAS	90DAS
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	1.36	3.56	3.50
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	1.75	4.25	4.19
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	1.70	4.19	4.16
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	1.42	3.19	3.11
T <sub>5</sub>	Fenoxaprop-p-ethyl 6.7% EC	56.95	1.39	3.17	3.13
T <sub>6</sub>	Oxadiargyl 80% WP	100	1.35	3.15	3.10
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	2.05	4.81	4.78
T <sub>8</sub>	Weedy check	-	1.33	3.03	2.95
SEm±			0.031	0.027	0.017
CD at 5%			0.09	0.081	0.051

#### 4.6. Yield attributing characters

##### 4.6.1 Effective tillers

Data on effective tillers (m<sup>-2</sup>) as influenced by different weed control treatments are depicted in Table 4.10(a). It is obvious from the data that effective tillers m<sup>-2</sup> varied significantly under different treatments. Among all the treatments, the minimum number of effective tillers m<sup>-2</sup> was recorded under weedy check (332.24) which enhanced significantly with increasing level of herbicide dose. Application of pyribenzoxim as post emergence @ 30 gha<sup>-1</sup> registered more effective tillers (384.27 m<sup>-2</sup>) and it was at par with pyribenzoxim @ 35 gha<sup>-1</sup> (376.56 m<sup>-2</sup>). However, the difference in effective tillers m<sup>-2</sup> under check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (375.85) and oxadiargyl @ 100 gha<sup>-1</sup> (379.16) was not marked. The highest number of

effective tillers  $m^{-2}$  was noted under hand weeding twice (502.31) which was appreciably superior over all the weed control treatments.

#### **4.6.2 Panicle length**

Data pertaining to panicle length of rice as influenced due to different treatments are presented in Table 4.10(a). Plots receiving of pyribenzoxim as post emergence @  $30 \text{ gha}^{-1}$  have remarkably high lengthy panicles (18.89 cm) and it was at par with pyribenzoxim @  $35 \text{ gha}^{-1}$  (18.82 cm) and comparison to its lower doses  $25 \text{ gha}^{-1}$  (18.61cm) and higher doses  $60 \text{ gha}^{-1}$  (18.79cm) and other check herbicide fenoxaprop-p-ethyl @  $56.95 \text{ gha}^{-1}$  (18.70cm) and oxadiargyl @  $100 \text{ gha}^{-1}$  (18.64cm) in respect of panicle length. Hand weeding twice registered maximum (18.98 cm) length of panicle which was significantly higher than rest of the treatments. The panicles were comparatively shorter under weedy check plots (18.36 cm).

#### **4.6.3 Total grains panicle<sup>-1</sup>**

The data on total grains panicle<sup>-1</sup> under different treatments are given in Table 4.10(a). It is clear from the data that application of pyribenzoxim as post emergence @  $30 \text{ gha}^{-1}$  (88.05) and it was at par with pyribenzoxim @  $35 \text{ gha}^{-1}$  (87.96) and higher significant as compared to rest of the dosage of pyribenzoxim @ 25 and  $60 \text{ gha}^{-1}$  (87.36 and 87.61) and check herbicide fenoxaprop-p-ethyl @  $56.95 \text{ gha}^{-1}$  (87.35) and oxadiargyl @  $100 \text{ gha}^{-1}$  (87.29). However, hand weeding twice resulted in maximum total grains panicle<sup>-1</sup> (90.54) which was appreciably more over all the weed control treatments. The total grains panicle<sup>-1</sup> were minimum (85.23) under weedy check plots where no weed control treatments were adopted.

#### **4.6.4 Sound grains panicle<sup>-1</sup>**

Sound grains panicle<sup>-1</sup> as influenced by different weed control treatments are depicted in Table 4.10(a). The result indicates that application of post emergence pyribenzoxim at different doses 25,30,35 and  $60 \text{ gha}^{-1}$  significantly influenced the sound grains panicle<sup>-1</sup>. Among all the treatments pyribenzoxim @  $30 \text{ gha}^{-1}$  registered more sound grains panicle<sup>-1</sup> (73.75) and it was at par with pyribenzoxim @  $35 \text{ gha}^{-1}$  (73.68) which was markedly superior over rest of the doses of pyribenzoxim @ 25 and  $60 \text{ gha}^{-1}$  (72.75 and

73.58) and check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (73.33) oxadiargyl @ 100 gha<sup>-1</sup>(73.28).However, hand weeding twice had significantly higher sound grains panicle<sup>-1</sup> (77.76) over all the weed control treatments. The sound grains panicle<sup>-1</sup> were lowest (70.45) under weedy check plots where no weed control treatment was applied.

#### **4.6.5 Sterility percentage**

The data on sterility percentage as affected due to different weed control treatments are given in Table 4.10(a). It is clear from the data that application of different weed control treatments appreciably influenced the sterility percentage. The percentage was minimum (14.19%) under hand weeding twice which was appreciably less over rest of the weed control treatments. It was also noticed that among the different doses of pyribenzoxim @ 25,30,35 and 60 gha<sup>-1</sup> its application @ 60 gha<sup>-1</sup> had markedly less sterility (16.01%). The highest sterility was noticed under weedy check plots (17.35 %).

#### **4.6.6 1000 grain weight**

The data related to 1000 grains weight of rice under different weed control treatments are presented in Table 4.10(a).It is obvious from the data that the 1000 grains weight did not varied due to different weed control treatments. The test weight was maximum (23.26g) with the hand weeding twice at 15 and 35 DAS and minimum (22.02 g) under weedy check plots. The result indicates that application of post emergence pyribenzoxim at different doses 25, 30, 35 and 60 gha<sup>-1</sup> significantly influenced the test weight of grain. Among all the treatments pyribenzoxim @ 30 gha<sup>-1</sup> registered more test weight (23.11 g) and it was at par with pyribenzoxim @ 35 gha<sup>-1</sup> (22.10g) which was markedly superior over rest of the doses of pyribenzoxim @ 25 and 60 gha<sup>-1</sup> (22.19 and 22.30g) and check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (23.01g) oxadiargyl @ 100 gha<sup>-1</sup>(23.00).

**Table 4.10(a): Effective tillers m<sup>-2</sup>, grains panicle<sup>-1</sup>, sound grains panicle<sup>-1</sup>, panicle length, sterility % and test weight at harvest of rice as influenced by different treatments**

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Effective Tillers m <sup>-2</sup>	Panicle length (cm)	Total Grains panicle <sup>-1</sup>	Sound Grains Panicle <sup>-1</sup>	Sterility percentage (%)	Test weight (g)
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	384.58	18.61	87.36	72.75	16.72	22.19
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	384.27	18.89	88.05	73.75	16.24	23.11
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	376.56	18.82	87.96	73.68	16.23	22.10
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	360.93	18.79	87.61	73.58	16.01	22.30
T <sub>5</sub>	Fenoxaprop- p-ethyl 6.7% EC	56.95	375.85	18.70	87.35	73.33	16.05	23.01
T <sub>6</sub>	Oxadiargyl 80% WP	100	379.16	18.64	87.29	73.28	16.04	23.00
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	502.31	18.98	90.54	77.76	14.19	23.26
T <sub>8</sub>	Weedy check		332.24	18.36	85.23	70.45	17.35	22.02
<b>SEm±</b>			4.66	0.13	0.11	0.17	-	0.5
<b>CD at 5%</b>			13.98	0.41	0.33	0.53	-	NS

#### 4.6.7 Grain yield

Grain yield of rice as influenced due to different weed control treatments are depicted in Table 4.10(b) and graphically represented through Fig. 4.6. It is clear from the result that different weed control treatments caused marked variations in grain yield of direct seeded rice. The grain yield was lowest in weedy check plots (1750.33 kg ha<sup>-1</sup>) where weeds were allowed to grow throughout the crop season but it was increased when pyribenzoxim was applied as post emergence @ 25, 35 and 60 gha<sup>-1</sup>. Its application @ 30 gha<sup>-1</sup> resulted in significantly higher grain yield (2328.54 kg ha<sup>-1</sup>) and over rest of the doses 25 and 60 gha<sup>-1</sup>. It was also noticed that pyribenzoxim @ 35 gha<sup>-1</sup> registered the second highest grain yield of (2308.48 kg ha<sup>-1</sup>). The lower dose of pyribenzoxim at 25 g ha<sup>-1</sup> (1954.00 kg ha<sup>-1</sup>) and higher dose of pyribenzoxim at 60 gha<sup>-1</sup> (2300.26 kg ha<sup>-1</sup>) and check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (2290.16 kg ha<sup>-1</sup>) and oxadiargyl @ 100 gha<sup>-1</sup> (2187.76 kg ha<sup>-1</sup>) gave less yield. The grain yield was appreciably higher (2917.91 kg ha<sup>-1</sup>) under hand weeding twice which was superior over all the weed control treatments.

#### 4.6.8 Straw yield

Data pertaining to straw yield of rice (kg ha<sup>-1</sup>) under different treatments are given in Table 4.10(b) and graphically depicted through Fig. 4.6. It is evident from the data that the weed control measures caused significantly varied on straw yield of rice. The straw yield was minimum in weedy check plots (2860.56 kg ha<sup>-1</sup>) where weed control measures were no adopted throughout the crop season, but worthy increment was noticed when pyribenzoxim was applied as post emergence @ 25, 30, 35 and 60 gha<sup>-1</sup>. The hand weeding at 15 and 35 DAS found the highest straw yield (4391.79 kg ha<sup>-1</sup>) which was significantly superior over other treatment followed by pyribenzoxim @ 30 gha<sup>-1</sup> (4057.63 kg ha<sup>-1</sup>) and pyribenzoxim @ 35 gha<sup>-1</sup> (4037.52 kg ha<sup>-1</sup>) were at par to each other. The lower dose of pyribenzoxim @ 25 gha<sup>-1</sup> (3419.77 kg ha<sup>-1</sup>) was equal in attaining straw yield as check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (3861.27 kg ha<sup>-1</sup>) and oxadiargyl @ 100 gha<sup>-1</sup> (3283.63 kg ha<sup>-1</sup>).

#### 4.6.9 Harvest index

The ratio between economic yield and biological yield expressed in percentage as affected by various treatments are presented in Table 4.10(b) and Fig. 4.7. In Among the various treatments, the minimum harvest index was recorded in weedy check (33.64) than pyribenzoxim @ 60 gha<sup>-1</sup> (36.30 %), which increased equally with the application different dose of pyribenzoxim @ 25, 30, and 35 gha<sup>-1</sup> (36.31,36.46,36.37 %). However, hand weeding twice (15 and 35 DAS) registered the highest harvest index (40.18%) and was significantly superior to other doses pyribenzoxim @ 25 to 35 and 60 gha<sup>-1</sup>, including check herbicide fenoxaprop-p-ethyl @ 56.95 g ha<sup>-1</sup> (37.22 %) and oxadiargyl @ 100 gha<sup>-1</sup> (39.91 %).

**Table 4.10(b) : Effect of different weed control treatments on grain yield, straw yield, harvest index**

<b>T. No.</b>	<b>Treatment</b>	<b>Dose (g a.i.ha<sup>-1</sup>)</b>	<b>Grain (kg ha<sup>-1</sup>)</b>	<b>Straw yield (kg ha<sup>-1</sup>)</b>	<b>Harvest index (%)</b>
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	1954.00	3419.77	36.31
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	2328.54	4057.63	36.46
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	2308.48	4037.52	36.37
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	2300.26	4035.50	36.30
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56.95	2290.16	3861.27	37.22
T <sub>6</sub>	Oxadiargyl 80% WP	100	2187.76	3283.63	39.91
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	2917.91	4391.79	40.18
T <sub>8</sub>	Weedy check	-	1750.33	2860.56	33.64
<b>SEm±</b>			55.32	42.91	-
<b>CD(P=0.05)</b>			167.43	129.88	-

## 4.7 Economic Analysis of the Treatments

The economic analysis of weed control treatments were determined on per hectare area basis, which includes cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio (profit over per rupee investment) under treatments imposed.

### 4.7.1 Cost of cultivation

Cost of cultivation was determined treatment wise on the basis of present market price of various common and variable agro-inputs used (Appendix-I). The values thus obtained are given in Table 4.11 and graphically depicted through Fig. 4.8. Data indicates that weedy check plots had the lowest cost of cultivation (Rs 27657 ha<sup>-1</sup>), which increased in the range of (Rs 28907 to Rs 29957 ha<sup>-1</sup>) with the increase in dose of pyribenzoxim @ 25, 30, 35 and 60 gha<sup>-1</sup> as post-emergence. Where as, hand weeding twice (15 and 35 DAS) had the highest cost of cultivation (Rs 37657).

### 4.7.2 Gross monetary returns

The value of economic produce (grain and straw) as per the existing market rates was taken into consideration for determining the gross monetary returns (GMR) under a particular treatment. The GMR was minimum (Rs 29985 ha<sup>-1</sup>) in weedy check plot which increased under all the plots receiving weed control treatments Table 4.11 and Fig. 4.8. The plots receiving two hand weeding fetched the higher GMR (Rs 49605 ha<sup>-1</sup>) followed by pyribenzoxim @ 30 gha<sup>-1</sup> (Rs 40141ha<sup>-1</sup>) and pyribenzoxim @ 35 gha<sup>-1</sup> (Rs 39811 ha<sup>-1</sup>).

### 4.7.3 Net monetary returns

The net monetary return (NMR) under each treatment was determined by subtracting the cost of cultivation from GMR of the particular treatment. The treatment wise values, thus obtained, are presented in Table 4.11 and Fig. 4.8. It is obvious from the data that NMR was (Rs 2328 ha<sup>-1</sup>) when crop was not weeded during crop season. However, it was increased with adoption of weed control treatments. The NMR was maximum (Rs 11948 ha<sup>-1</sup>) under hand weeding twice followed by pyribenzoxim @ 30 gha<sup>-1</sup> (Rs 11084 ha<sup>-1</sup>) suggesting that weed control with pyribenzoxim @ 30 gha<sup>-1</sup> was more profitable than hand weeding twice which required the highest investment on weeding i.e. Rs (11948 ha<sup>-1</sup>) more than pyribenzoxim @ 30 gha<sup>-1</sup>.

#### 4.7.4 Benefit-cost ratio

It refers to net monetary gain under a particular treatment with each rupee of investment. The benefit-cost ratio as affected by different treatments are depicted in Table 4.11 and fig. 4.9. It is evident from the data that B:C ratio was maximum under pyribenzoxim @30 gha<sup>-1</sup> (1.38) followed by equally pyribenzoxim @ 35 gha<sup>-1</sup> (1.36) and hand weeding twice at 15 and 35 DAS (1.31). However, the benefit per rupee of investment was comparatively less when lower dose pyribenzoxim @ 25 gha<sup>-1</sup> (1.16) and higher(double) dosage of pyribenzoxim @ 60 gha<sup>-1</sup> (1.32) and check herbicide fenoxaprop-p-ethyl @ 56.95 gha<sup>-1</sup> (1.33) oxadiargyl @ 100 gha<sup>-1</sup> (1.27).

**Table 4.11: Economic analysis of different weed control treatments**

T. No.	Treatment	Dose (g a.i.ha <sup>-1</sup> )	Cost of cultivation (Rs ha <sup>-1</sup> )	GMR <sup>-1</sup> (Rs ha <sup>-1</sup> )	NMR <sup>-1</sup> (Rs ha <sup>-1</sup> )	B:C Ratio
T <sub>1</sub>	Pyribenzoxim 500 ml/ha	25	28907	33706	4799	1.16
T <sub>2</sub>	Pyribenzoxim 600 ml/ha	30	29057	40141	11084	1.38
T <sub>3</sub>	Pyribenzoxim 700 ml/ha	35	29207	39811	10604	1.36
T <sub>4</sub>	Pyribenzoxim 1200 ml/ha	60	29957	39685	9728	1.32
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56.95	29219	38970	15751	1.33
T <sub>6</sub>	Oxadiargyl 80% WP	100	29157	37182	8025	1.27
T <sub>7</sub>	Hand weeding twice	15 and 35 DAS	37657	49605	11948	1.31
T <sub>8</sub>	Weedy check	-	27657	29985	2328	1.08

## DISCUSSION

Results obtained under the present investigation are described in previous chapter. An effort has been made in this chapter to discuss significant results of the experiment duly supported with appropriate reasons, findings of research workers and data obtained on various parameters of weed and crop during the course of investigation.

Various components of natural environment particularly edaphic and climatic conditions, besides the cultural practices adopted in a particular crop influence the extent of weed flora and production of a crop in an interacting manner. Thus, influence of edaphic and climatic conditions on weed flora and crop yield also has great concern, which can not be ignored. Therefore, the existing soil and weather conditions of the experimental area were also taken into consideration prior to discuss the findings of the present investigation

### **5.1 Edaphic variations**

The extent of weed flora and crop growth in an area mainly depends on the soil type and its characteristics. The data on physico-chemical properties of soil indicates that the soil of experimental field was sandy loam, homogenous in fertility and soil reaction (Table 3.3). These characteristics of soil are dominant in the soils of Jabalpur region. Thus, the finding of the present investigation could be applied to the similar soil conditions of this region

### **5.2 Weather variations**

Weather factors or parameters, temperature ( maximum and minimum), rainfall (its intensity and duration), relative humidity and sunshine hours) during crop season plays an important role in crop production. All the weather parameters except rainfall during the crop season were almost normal (Table 1 and Fig. 1). The rainfall deviated from its average of the locality. As a whole, the weather conditions prevailed during crop season were conducive for proper growth and development of rice crop.

### 5.3 Dominant weed flora

Species wise weed data at 15, 30 and 45 DAA in weedy check plot (Table 4.1 and Fig. 4.1 (a)) exhibited that there was predominance of monocot (*Cyperus rotundus*, *Echinochloa colona* and *Digitaria sanguinalis*) and broad leaved (*Alternanthera sessilis* and *Physalis minima*) weeds in the experimental field. Among the weeds *Cyperus rotundus* was more rampant (18.50 % at 60 DAT) due to their continuous regrowth during the crop season. Similar weed flora in rice has also been reported by Mahajan *et al.* (2003), Kabdal *et al.* (2014), Duary *et al.* (2015), and Punia *et al.* (2016).

### 5.4 Density and dry weight of weeds

Significant variations in the density and dry weight of *Cyperus rotundus*, *Echinochloa colona*, *Digitaria sanguinalis*, *Alternanthera sessilis* and *Physalis minima* under different weed control treatments were observed Table 4.2(a), (b) and (c) and 4.3(a), (b) and (c) Fig. 4.2 (a), (b) (c), (d) and (e) and 4.3 (a), (b), (c) (d) and (e). It was noticed that the density and dry weight of all these weeds were maximum under weedy check plots at all the growth intervals. This was attributed to non adoption of weed control measure in the weedy check plots. The density and dry weight of these weeds were reduced when the weeds were controlled through the herbicide and hand weeding. The reduction in the density and dry weight of all the weeds was marginal with the application of pyribenzoxim @ 25 gha<sup>-1</sup> as post emergence and check herbicides, fenoxaprop- p-ethyl 6.7%EC and oxadiargyl 80% wp. All these weeds were controlled effectively with the application of pyribenzoxim as post emergence @ 60 gha<sup>-1</sup>. Similar results were also reported by Moon Byeong-Chul (2002), and H.M.S. Herath *et al.* (2005).

### 5.5 Effect on crop growth parameters

Remarkable variations in growth parameters at all the growth intervals of rice (i.e. at 30, 60, 90 DAS and harvest) were noticed due to different weed control treatments. The results obtained on the growth parameters (viz. plant height, number of tillers, LAI) were discussed as under.

### **5.5.1 Plant height and number of tillers**

Significantly taller plants and more tillers  $\text{m}^{-2}$  were noted with the application of pyribenzoxim @  $30 \text{ gha}^{-1}$  or hand weeding twice over weedy check (Table 4.6). This was attributed to enhanced availability of growth resources especially nitrogen and space which helped in producing taller plants and professed number of tillers  $\text{m}^{-2}$ .

### **5.5.2 Leaf area index (LAI)**

Leaf area index influenced the production of biomass in any crop and its relationship with biological yield was well established in cereals Welbank *et al.* (1968). LAI is an important character depends on leaf orientation. The vertically oriented leaves had a higher photosynthesis rate than those with horizontal leaves. Modern rice varieties with higher productivity were found to have erect leaves than older varieties (Tanaka *et al.*, 1966).

The present study (Table 4.9) indicated that hand weeding twice possessed the maximum LAI (4.78) at 60 DAS over the other treatments which was attributed to the availability of optimum growth factors for enhancing the assimilatory surface area. The weed free environment provides more chance for leaves to expand and cover the area by its canopy in an appreciable manner. On the other hand the minimum LAI (3.11) at 60 DAS was noted with weedy check which may be resultant of improper development of assimilatory surface area under the treatment which allow to grow more number of weeds.

## **5.6 Dry matter production**

The higher dry matter accumulation in plant and its proper mobilization to sink during the crucial period of sink filling play a key role in determining the yield potential of a genotype. The photosynthetic capacity of leaves becomes more crucial especially during the low light intensities (Akiyama *et al.*, 1975). Generally thick leaves were found to be associated with higher photosynthetic rates (Murata, 1961).

The dry matter production  $\text{m}^{-2}$  in rice crop linearly increased with the advancement in the growth stages till the maturity stage with the rapid rate of increment during the period between 30 to 60 DAS. The rate of increase in DMP  $\text{plant}^{-1}$  was very slow at early growth stage (30 DAS). Plant height, tillers

$\text{m}^{-2}$ , number of leaves  $\text{m}^{-2}$  and leaf area  $\text{m}^{-2}$  were minimum up to 30 DAS, therefore a little food materials accumulated and photosynthates synthesized in plants was utilized for the development of vegetative parts of plants at very early stage (30 DAS), which resulted into slow rate of DM accumulation by the plant. Further development of vegetative parts increases the DMP  $\text{m}^{-2}$  which was continued till 60 DAS. During 30 to 60 DAS, plants attained their maximum height, tillers  $\text{m}^{-2}$ , number of leaves  $\text{m}^{-2}$  and leaf area  $\text{m}^{-2}$ , therefore rate of DM production  $\text{m}^{-2}$  was maximum at 30 to 60 DAS. The vegetative phase of plant was almost completed till 60 DAS and then plants entered into their reproductive phase, therefore accumulated photosynthetes and food materials were utilized mainly for the development of seeds so the DM production was also increase during 60 to 90 and harvest stage but less than from 30 to 60 DAS. Consequently, dry matter accumulation by plants increased till the maturity stage.

In the present study it was noticed that maximum dry matter production under hand weeding twice (7.46, 34.53, 98.81 and 100.15  $\text{g m}^{-2}$ ) followed by the application of pyribenzoxim as post emergence @ 30  $\text{gha}^{-1}$  resulted in the higher dry matter production in plant (7.69, 31.94, 91.32, and 93.26  $\text{g m}^{-2}$ ) throughout the reproductive growth period which is a beneficial trait from yield point of view. Weedy check plots registered the minimum production of assimilates in the assimilatory apparatus (6.26, 28.83, 76.69 and 77.89  $\text{g m}^{-2}$ ) at 30, 60, 90 and harvest. The minimum magnitude of dry matter under weedy check might be owing to the increased competition among crop and weeds which have hampered the plant growth resulting in reduced dry matter production (Dewangan *et al.* 2011)

### **5.7 Effect on yield attributing characters**

Appreciably lowest effective tillers  $\text{m}^{-2}$  and panicle length were noted under weedy check plots (Table 4.10(a)). Heavy weed competition hampered the supply of growth resources below the demand resulting in poor vegetative growth and reduced assimilatory area per unit of ground area. The effective tillers  $\text{m}^{-2}$  were increased markedly with corresponding increase in the doses pyribenzoxim being higher when it was applied 30  $\text{gha}^{-1}$  (384.27  $\text{m}^{-2}$ ). The effective tillers were significantly more with hand weeding twice (502.31  $\text{m}^{-2}$ )

in comparison to rest of the treatments. This was attributed to weed free environment throughout the critical period which resulted in better growth and development of foliage and finally more effective tillers. These findings are in conformity to those of Chandra and Solanki (2003) and Chauhan *et al.* (2013).

Significantly higher number of total (90.54 and 88.05) and sound (76.76 and 73.75) grains panicle<sup>-1</sup> were noted under hand weeding twice and pyribenzoxim @ 30 gha<sup>-1</sup>. This was due to better suppression of weeds and the weed free environment to the crop, gave more food for formation and development of grains which led to register the superior values of total and sound grains panicle<sup>-1</sup> under aforesaid treatments. These results are in accordance with the findings of Chandra and Solanki (2003), Singh *et al.* (2006) and Chauhan *et al.* (2013).

In the present investigation the sterility percentage was lowest (14.19 %) under hand weeding twice and highest (17.35 %) in weedy check plots. Pyribenzoxim as post emergence @ 30 and 35 gha<sup>-1</sup> had almost similar sterility and both the doses were significant over its lower doses @ 25 gha<sup>-1</sup>. The lowest sterility in case of hand weeding was owing to weed free condition which possibly enhanced the utilization of more photosynthate towards sink and finally reduced the sterility. Similar reduction in sterility was also reported by Chander and Pandey (1996).

The 1000 grains weight (g) was not significantly differed under various weed control treatments. The possible reason for non-significant differences in test weight under the treatments was due to similarity in size and shape of individual grains. (Chauhan *et al.*, 2013)

## **5.8 Grain and straw yield**

In the present study the lowest grain and straw yields (Table 4.10(b) and Fig.4.6) were noted under weedy check plots in which weeds were allowed to grow throughout the crop season. This resulted in severe crop-weed competition for available growth resources which resulted in the inferior growth and yield attributing characters as well as dry matter in leaves, stem and panicle length, effective tillers, sound grains which resulted in lowest yields. Significant increase in yields (grain and straw) were observed with the

different doses of pyribenzoxim when applied @ 25, 30, 35, and 60 gha<sup>-1</sup> being highest (2328.54 and 4057.63kg ha<sup>-1</sup>) at 30 gha<sup>-1</sup>. The grain and straw yields noted under hand weeding twice were appreciably more (2917.91 and 4391.79 kg ha<sup>-1</sup>) over all the treatments. The enhanced yields under these treatments was because of elimination of weeds which helped in enhancing the availability of nutrients, space, sunlight and water resulting in better growth and development of crop plants. This caused better yield attributing characters and accumulation of more dry matter (Table 4.5.4) ultimately the highest yields. These results are in collaboration with the findings of, Chauhan and Opena (2013) and Kumar *et al.* (2014).

### **5.9 Harvest index**

Different weed control treatments failed to exhibit significant variations in harvest index. The maximum value of this index (40.18%) was noted under hand weeding twice which was owing to higher coefficient of partitioning of photosynthetes in sink. Chandra and Solanki (2003) also reported similar results.

### **5.10 Weed index**

The index was maximum (43.00%) in weedy check plots due to presence of more weeds while it was minimum (23.50%) with pyribenzoxim @ 35 gha<sup>-1</sup>. The minimum weed index noted under later treatment (i.e. pyribenzoxim @ 30 gha<sup>-1</sup>) was owing to effective control of weeds.

### **5.11 Weed control efficiency**

Weed control efficiency under a treatment had strongly reverse relationship with weed biomass. Maximum (96.37%) weed control efficiency was noted under hand weeding twice. This was attributed to removal of weeds which reduced the biomass production under these treatments. These results are in collaboration with the findings of Singh and Prajapati (2006) and Chandra *et al.* (1998).

### **5.12 Economic viability of treatments**

Economic evaluation of the treatments is also important to know the practical utility of a treatment to the farmers. The cost of cultivation was maximum under hand weeding twice owing to an additional expenditure of Rs 12000 ha<sup>-1</sup> on weeding. This in general is not feasible to farmers due to high

investment and also unavailability of adequate laborers at peak period of demand. The different doses of pyribenzoxim required lesser investment as compared to hand weeding twice.

### **Gross Monetary Returns (GMR)**

The values of Gross monetary returns were minimum (Rs 29985 ha<sup>-1</sup>) in weedy check plot and maximum (Rs 49605 ha<sup>-1</sup>) under hand weeding twice. It was noticed that application of pyribenzoxim @ 30 gha<sup>-1</sup> could not compensate the GMR as obtained with hand weeding twice but the later treatment (i.e. hand weeding twice) had the higher investment. These variations were due to differences in economical yield (grain and straw) under the treatments.

### **Net Monetary Returns (NMR)**

The net monetary returns (NMR) was also minimum (Rs 2328 ha<sup>-1</sup>) under weedy check, which increased to the range of Rs 4799 to 11084 ha<sup>-1</sup> and decrease to the range of Rs 10604 to 9728 ha<sup>-1</sup> under those treatments where weeds were controlled by herbicides. The NMR under pyribenzoxim @ 30 gha<sup>-1</sup> was Rs 11084 ha<sup>-1</sup>, which was followed by pyribenzoxim @ 35 gha<sup>-1</sup> Rs 10604ha<sup>-1</sup>. It is noteworthy that although the hand weeding fetched the highest GMR and the NMR (Rs 11948 ha<sup>-1</sup>), because of higher grain yield. Similar results were also reported by Sah *et al.* (2012).

### **Benefit-cost ratio**

It represents the profitability or monetary gain under a particular treatment with each rupee of investment. The ratio was minimal (1.08) under weedy check plots. It being the higher (1.38) when pyribenzoxim @ 30 gha<sup>-1</sup> followed by pyribenzoxim @ 35 gha<sup>-1</sup> due to proportionate increase in economical yield because of effective control of weeds. But B:C ratio under hand weeding twice was less than pyribenzoxim @ 30 gha<sup>-1</sup> because of high cost of cultivation under hand weeding. Similar results were also reported by Jacob *et al.* (2014) and sah *et al.* (2012).

However pyribenzoxim applied @ 60 gha<sup>-1</sup> was more effective to control weeds but simultaneously its phytotoxic effect on crop was found so ultimately yield losses take place and economically not found suitable

## SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

### 6.1 Summary

The present investigation was conducted at the Krishi Nagar Research Farm of Agronomy, JNKVV, Jabalpur during *kharif* 2017, to study **"Evaluation of post emergence application of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura hills"**. The soil of the experimental field was sandy clay loam in texture, medium in organic carbon and available nitrogen, Phosphorus and potassium content and neutral in soil reaction. The experiment was laid out in randomized block design with ten weed control treatments comprising of pyribenzoxim @ 25 to 60 gha<sup>-1</sup> as post emergence , fenoxaprop-p-ethyl 6.7% EC @ 56.95 gha<sup>-1</sup>, oxadiargyl 80% WP @ 100 gha<sup>-1</sup>, hand weeding twice at 15 and 35 DAS and weedy check replicated three times.

The rice variety MTU 1010 was grown on 4 July 2017 with seed rate 70kg. ha<sup>-1</sup> at gross plot size of 5.25x3.6m had replication distance 1.5 m. Sowing of seeds in each plot was done in rows 20 cm apart at the depth of 2-3 cm and then seeds were covered with fine soil. Rice crop was well supplied with recommended dose of fertilizers (N:P:K) i.e. 120:60:40 kg ha<sup>-1</sup>.

Different observations on weeds and crop were made during the course of investigation. Dominant weed flora, species wise weed density and their dry weight was recorded under all the treatments at 15, 30 and 45 DAA. Plant population of direct seeded rice was noted at 15 DAS and harvest. Growth parameters (viz., plant height, and tillers m<sup>-2</sup>) and dry weight of plant were recorded at different days interval. Yield attributing traits (viz., effective tillers m<sup>-2</sup>, total grains panicle<sup>-1</sup>, sound grains panicle<sup>-1</sup> and 1000 grain wt. (g) were recorded at maturity. Thereafter, yields (grain and straw) was determined treatment wise. Finally, weed index, weed control efficiency, harvest index and economic viability of treatments were calculated from the data obtained.

Tabulation and statistical analysis of data was done for testing the significance among the different treatments. The results are summarized as under.

### 6.1.1 Effect on weeds

The data was recorded on density and dry weight of weeds and the comparison in the treatment means were done on transformed values. In the experimental field, *Digitaria sanguinalis* (22.86 %) was the rampant weed closely followed by *Physalis minima* (21.38%). However, monocot weeds like *Cyperus rotundus* (18.50%) and *Echinochloa colona* (17.02%) and dicot weed like *Alternanthera sessilis* (21.21%) were also present in less numbers in weedy check plots. The plots receiving no weed control had significantly higher weed density than all the herbicidal treatments including hand weeding twice. The weed menace was almost zero under the hand weeding twice (15 and 35 DAS) but it was increased at harvest due to emergence of perennial weeds during later part of crop growth. Weedy check plots had the highest weed biomass, which reduced significantly when weeds were controlled either chemically or mechanically. The lowest weed biomass was recorded under hand weeding twice, which proved significantly superior to all the herbicidal treatments. Maximum weed control efficiency in weeds (96.37) was noted under hand weeding twice due to the lowest weed biomass production. However pyribenzoxim applied @ 60 gha<sup>-1</sup> was more effective to control weeds but simultaneously its phytotoxic effect on crop was found so ultimately yield losses take place and economically not found suitable.

### 6.1.2 Effect on crop

Growth parameters of rice (viz. plant height, number of tillers m<sup>-2</sup>) were higher in plots receiving pyribenzoxim @ 30 gha<sup>-1</sup> all the weed control treatments except for hand weeding twice (as complete elimination of weed was there) which had the maximum values of these parameters. Dry matter accumulation in plant were also higher in hand weeding twice followed by pyribenzoxim as post emergence @ 30 gha<sup>-1</sup>.

Yield attributes (viz. Effective tillers  $m^{-2}$ , total and sound grains panicle $^{-1}$ ) were significantly higher under hand weeding twice followed by pyribenzoxim @30  $gha^{-1}$ . While the test weight of rice was not influenced due to different weed control treatments.

Grain and straw yields were significantly higher under all the weed control treatments over weedy check plots. Application of pyribenzoxim as post emergence @30g  $ha^{-1}$  recorded higher of grain and straw yields (2328.54 and 4057.63  $kg. ha^{-1}$ ) followed by yields pyribenzoxim @ 35  $gha^{-1}$  (2308.48 and 4037.52  $kg. ha^{-1}$ ). Even though the highest yield were recorded with hand weeding twice but economically not feasible.

Harvest index was maximum (40.18%) under hand weeding twice followed by of pyribenzoxim @30  $gha^{-1}$  and minimum (33.64%) with weedy check plots. While weed index was minimum under hand weeding twice(0.00%) followed by pyribenzoxim @ 30  $gha^{-1}$  (24.18%). The weed control efficiency was maximum (96.37%) under hand weeding twice. Application of pyribenzoxim as post emergence @ 30  $gha^{-1}$  (76.85%) and pyribenzoxim as post-emergence @ 35  $gha^{-1}$  (79.31%) but higher doses are not economically feasible.

### **6.1.3 Economic viability of treatments**

Pyribenzoxim @ 30 $gha^{-1}$  was the economically viable treatment among all the weed control treatments. The cost of cultivation was maximum (Rs 37657  $ha^{-1}$ ) under hand weeding twice owing to an additional expenditure of Rs 10000 on weeding, showing that control of weeds through hand weeding twice was more expensive than the use of herbicide in rice crop. Although the gross monetary returns was maximum (Rs 49605.  $ha^{-1}$ ) in hand weeding twice among all the treatments and net monetary returns was also maximum under hand weeding twice at 15 and 30 DAS (Rs 11948.  $ha^{-1}$ ) but it was not economically viable as it gave only 1.31 B:C ratio which was lower to pyribenzoxim @ 30  $gha^{-1}$  (1.38).

## 6.2 Conclusions

Based on the aforesaid discussion the following conclusions could be made there was predominance of monocot weed *Digitaria sanguinalis* (21.86%) and *Cyperus rotundus* (18.50%) and *Echinochloa colona* (17.07%) in direct seeded rice. However, dicot weeds like *Physalis minima* (21.38%), *Alternanthera sessilis* (21.19%) also marked their presence in high numbers. Application of pyribenzoxim @ 30 gha<sup>-1</sup> was found suitable for effective control of weeds followed by pyribenzoxim @ 35 gha<sup>-1</sup> in direct seeded rice.

Growth parameters (viz. plant height, number of tillers m<sup>-2</sup> and LAI), yield attributes (viz. effective tillers m<sup>-2</sup>, panicle length, total and sound grains panicle<sup>-1</sup>) and yields (grain and straw) were significantly more with the application of pyribenzoxim @ 30 gha<sup>-1</sup> as compared to rest of the doses.

Application of pyribenzoxim @ 30 gha<sup>-1</sup> found more remunerative followed by pyribenzoxim @ 35 gha<sup>-1</sup> as both received higher values of NMR (Rs.11084 and Rs.10604 ha<sup>-1</sup>) and B:C ratio (1.38 and 1.36), respectively (Table 4.11).

## 6.3 Suggestions for further work

1. Following suggestions could be made for future studies based on the results of the present investigations.
2. The experiment needs to be tested on the same site and other location for at least 2-3 years to confirm the present findings.
3. Pyribenzoxim is to be tested in combination with other broad leaved and grassy weed killers to ensure broad spectrum weed control.
4. These treatments need to be tested with other mechanical means (viz. touchy gurma) to ensure effective and economical weed control.

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## APPENDICES

### Appendix-I

**[A] Cost of cultivation per hectare area basis (Excluding cost of treatments)**

Sr. No.	Particulars	Input (ha <sup>-1</sup> )	Cost /Unit (Rs. ha <sup>-1</sup> )	Cost (Rs ha <sup>-1</sup> )
<b>A</b>	<b>Land preparation</b>			
I	Harrowing with Cultivator	1 pass	500/hr	1250
II	Harrowing with Disc harrow	2 pass	500/hr	2000
III	Leveling	1 pass	250/hr	500
<b>B</b>	<b>Seed and sowing</b>			
I	Cost of seed	70kg	20/kg	1400
II	Seed treatment			
	Carbendazim	150g	2000/kg	300
III	Seed treatment charges	1 man day	250/day	250
IV	Sowing charges	Seed drill	750/ha	750
		2 man day	250/day	500
<b>C</b>	<b>Fertilizers</b>			
I	Cost of fertilizers			
	N	120 kg	12.82/kg	1539
	P <sub>2</sub> O <sub>5</sub>	60 kg	32.86/ kg	1972
	K <sub>2</sub> O	40 kg	18.62/ kg	746
	Transport charge			150
II	Application charges	2 man day	250/day	500
III	Top dressing of urea	4 man day	250/day	1000
<b>D</b>	Irrigation with labour charges	400 +4 man day	250/day	1400
<b>E</b>	Thinning	2 man day	250/day	500
<b>F</b>	Harvesting, bundling and transportation	15 man days	250/day	3750
<b>G</b>	Threshing and winnowing	5 man days	250/day	1250
<b>H</b>	Land rent	6 month	20000/yr	8000
<b>Total</b>				<b>27657</b>

**[B] Estimation of variable cost of cultivation due to various weed control treatments (on per hectare area basis)**

<b>T. No.</b>	<b>Treatment</b>	<b>dose (ai ha<sup>-1</sup>)</b>	<b>Commercial Dose</b>	<b>Unit price (Rs litre<sup>-1</sup> or kg)</b>	<b>Cost (Rs ha<sup>-1</sup>) including application charges (Rs400 ha<sup>-1</sup>)</b>
T <sub>1</sub>	Pyribenzoxim 5%EC	25	500	1500	1250
T <sub>2</sub>	Pyribenzoxim 5%EC	30	600	1500	1400
T <sub>3</sub>	Pyribenzoxim 5%EC	35	700	1500	1550
T <sub>4</sub>	Pyribenzoxim 5%EC	60	1200	1500	2300
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	56	850	1250	1562
T <sub>6</sub>	Oxadiargyl 80% WP	100	125	8000	1500
T <sub>7</sub>	Hand weeding twice at 15 and 35DAS	15 and 35 DAS	20 labour	10000	
T <sub>8</sub>	Weedy check				

**[C] Economic analysis of different weed control treatments in rice**

<b>T. No.</b>	<b>Treatment</b>	<b>Cost of weed control (Rs ha<sup>-1</sup>)</b>	<b>Common Cost of cultivation t (Rs ha<sup>-1</sup>)</b>	<b>Cost of cultivation with treatment (Rs ha<sup>-1</sup>)</b>
T <sub>1</sub>	Pyribenzoxim 25g a.i.	1250	<b>27657</b>	28907
T <sub>2</sub>	Pyribenzoxim 30g a.i.	1400	<b>27657</b>	29057
T <sub>3</sub>	Pyribenzoxim 35g a.i.	1550	<b>27657</b>	29207
T <sub>4</sub>	Pyribenzoxim 60g a.i.	2300	<b>27657</b>	29957
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	1562	<b>27657</b>	29219
T <sub>6</sub>	Oxadiargyl 80% WP	1500	<b>27657</b>	29157
T <sub>7</sub>	Hand weeding twice at 15 and 35 DAS	10000	<b>27657</b>	37657
T <sub>8</sub>	Weedy check	00	<b>27657</b>	27657

**[D] Economic analysis of different weed control treatments in rice**

T.No.	Treatment	Grain yield (kg ha <sup>-1</sup> )	Values of grain (Rs ha <sup>-1</sup> )	Stover yield (Kg ha <sup>-1</sup> )	Value of stover (Rs ha <sup>-1</sup> )	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross monetary returns (Rs ha <sup>-1</sup> )	Net monetary returns (Rs ha <sup>-1</sup> )	B:C Ratio
T <sub>1</sub>	Pyribenzoxim 25g a.i.	1954.00	30287	3419.77	3419	28907	33706	4799	1.16
T <sub>2</sub>	Pyribenzoxim 30g a.i.	2328.54	36084	4057.63	4057	29057	40141	11084	1.38
T <sub>3</sub>	Pyribenzoxim 35g a.i.	2308.48	35774	4037.52	4037	29207	39811	10604	1.36
T <sub>4</sub>	Pyribenzoxim 60g a.i.	2300.26	35650	4035.50	4035	29957	39685	9728	1.32
T <sub>5</sub>	Fenoxaprop p-ethyl 6.7% EC	2290.16	35495	3861.27	3861	29219	38970	15751	1.33
T <sub>6</sub>	Oxadiargyl 80% WP	2187.76	33899	3283.63	3283	29157	37182	8025	1.27
T <sub>7</sub>	Hand weeding twice at 15and 35DAS	2917.91	45214	4391.79	4391	37657	49605	11948	1.31
T <sub>8</sub>	Weedy check	1750.33	27125	2860.56	2860	27657	29985	2328	1.08

**Price of grain = Rs 15.5 kg**

**Price of straw =Rs 1 kg**

**[A] Mean sum of square for weed density in rice at 15, 30 and 45 DAA**

S. No.	Sources of variation	d.f	Density of dominant weeds ( m <sup>-2</sup> )								
			<i>Echinochloa colona</i>			<i>Cyperus rotundus</i>			<i>Digitaria sanguinalis</i>		
			15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS1	15 DAS	30 DAS	45 DAS
1	Replication	2	0.09	0.03	0.13	0.03	0.09	0.01	0.01	0.10	0.07
2	Treatment	7	8.36	8.90	9.68	9.22	9.74	11.05	10.35	10.97	11.76
3	Error	14	0.03	0.04	0.03	0.02	0.01	0.03	0.02	0.02	0.01

**[B] Mean sum of square for weed density in rice at 15, 30 and 45 DAA**

S. No.	Sources of variation	d.f	Density of dominant weeds (m <sup>-2</sup> )					
			<i>Alternanthera Sessilis</i>			<i>Physalis minima</i>		
			15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
1	Replication	2	0.58	0.03	0.01	0.01	0.02	0.48
2	Treatment	7	15.19	16.38	20.35	16.48	18.34	19.84
3	Error	14	0.01	0.02	0.03	0.01	0.05	0.04

**[c] Mean sum of square for dry weight of weed in rice at 15, 30 and 45 DAA**

S. No.	Sources of variation	d.f	Dry weight of dominant weeds (g m <sup>-2</sup> )								
			<i>Echinochloa colona</i>			<i>Cyperus rotundus</i>			<i>Digitaria senguinalis</i>		
			15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
1	Replication	2	0.40	0.69	0.20	0.01	0.32	0.29	0.30	0.52	0.04
2	Treatment	7	5.65	9.49	12.82	5.97	9.31	13.64	5.75	10.08	10.05
3	Error	14	0.02	0.04	0.01	0.05	0.02	0.02	0.02	0.07	0.02

**[D] Mean sum of square for dry weight of weed in rice at 15, 30 and 45 DAA**

S. No.	Sources of variation	d.f	Dry weight of dominant weeds (g m <sup>-2</sup> )					
			<i>Alternanthera Sessilis</i>			<i>Physalis minima</i>		
			15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
1	Replication	2	0.30	0.33	0.13	0.05	0.38	0.10
2	Treatment	7	12.89	19.33	21.60	12.13	15.11	20.30
3	Error	14	0.02	0.03	0.01	0.03	0.03	0.01

**[E] Mean sum of square for different growth parameter**

Source of variation	d.f.	Plant height (cm)				Number of tillers m <sup>-2</sup>			
		30 DAS	60 DAS	90 DAS	harvest	30 DAS	60 DAS	90 DAS	Harvest
Replication	2	13.29	16.91	2.25	3.19	2239.38	110.87	1.32	2.05
Treatment	7	2.06	1.69	1.79	1.72	19166.07	26381.12	28167.59	27836.13
Error	14	0.57	0.94	0.48	0.47	423.18	112.89	1.32	2.05

**[F] Mean sum of square for Plant Population and Plant Dry matter accumulation**

Source of variation	d.f.	Plant Population		Dry matter accumulation (g m <sup>-2</sup> )			
		15 DAS	harvest	30 DAS	60 DAS	90 DAS	Harvest
Replication	2	0.15	8.48	0.02	0.03	0.64	2.15
Treatment	7	0.40	1.88	0.53	7.49	131.60	127.84
Error	14	0.23	3.06	0.06	0.02	0.18	0.48

**Effective tillers, grains panicle<sup>-1</sup>, sound grains panicle<sup>-1</sup>, panicle length, sterility and test weight at harvest of rice as influenced by different treatment**

T. No.	Treatment	Dose (g a.i. ha <sup>-1</sup> )	Effective Tillers m <sup>-2</sup>	Panicle length (cm)	Total Grains panicle <sup>-1</sup>	Sound Grains Panicle <sup>-1</sup>	Sterility percentage (%)	Test weight (g)	Grain <sup>-1</sup> (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )
T <sub>1</sub>	Pyribenzoxim 25g a.i.	25	384.58	18.61	87.36	72.75	16.72	22.19	1954.00	3419.77
T <sub>2</sub>	Pyribenzoxim 30g a.i.	30	384.27	18.89	88.05	73.75	16.24	23.11	2328.54	4057.63
T <sub>3</sub>	Pyribenzoxim 35g a.i.	35	376.56	18.82	87.96	73.68	16.23	22.10	2308.48	4037.52
T <sub>4</sub>	Pyribenzoxim 60g a.i.	60	360.93	18.79	87.61	73.58	16.01	22.30	2300.26	4035.50
T <sub>5</sub>	Fenoxaprop-p-ethyl 6.7% EC	56.95	375.85	18.70	87.35	73.33	16.05	23.01	2290.16	3861.27
T <sub>6</sub>	Oxadiargyl 80% WP	100	379.16	18.64	87.29	73.28	16.04	23.00	2187.76	3283.63
T <sub>7</sub>	Hand weeding twice	15 & 35 DAS	502.31	18.98	90.54	77.76	14.19	23.26	2917.91	4391.79
T <sub>8</sub>	Weedy check		332.24	18.36	85.23	70.45	17.35	22.02	1750.33	2860.56
SEm±			4.66	0.13	0.11	0.17	-	0.20	55.32	42.91
CD (P=0.05)			13.98	0.41	0.33	0.53	-	0.60	167.43	129.88

## ABSTRACT

**Title of the thesis** : “Evaluation of post emergence applications of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura Hills”

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**Degree awarded** : M.Sc. (Ag.) Agronomy

**Year of award of Degree** : 2018

**Members of the advisory committee** : Dr. J. K. Sharma  
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Dr. H.L. Sharma

**Major Subject** : Agronomy

**Name of the college** : Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Jabalpur

**Total number of pages in the thesis** : 80

**Number of words in the abstract** : 210

**Dr. Rajendra Prasad Sahu**  
(Advisor)

**Dr. Girish Jha**  
(Professor & Head)

**Rajul Soni**  
(Student)

## ABSTRACT

A field experiment entitled "Evaluation of post emergence applications of pyribenzoxim against weeds in direct seeded rice" was conducted during Kharif season of 2017. The eight treatments comprising of four doses of pyribenzoxim @ 25,30,35 and 60 g ha<sup>-1</sup>, alone application of Fenoxaprop- p-ethyl 56.95 g ha<sup>-1</sup>, and Oxadiargyl 100 g ha<sup>-1</sup> as post-emergence, hand weeding twice at 15 and 35 DAS including weedy check, were laid out in randomized block design with 3 replications. *Digitaria sanguinalis* (21.86%) was rampant closely followed by *Physalis minima* (21.38 %). However, other weeds like *Cyperus rotundus*, *Echinochloa colona*. and *Alternanthera sessilis* were also present in less numbers with rice in weedy check plots. Application of pyribenzoxim @30 g ha<sup>-1</sup> was found suitable for effective control of weeds followed by pyribenzoxim @35 g ha<sup>-1</sup> in direct seeded rice. Growth parameters(viz. effective tillers m<sup>-2</sup> and LAI), yield attributes (viz. effective tillers m<sup>-2</sup>, panicle length, total and sound grains penicle<sup>-1</sup>) and yields (grain and straw) were significantly more with the application of pyribenzoxim @30g ha<sup>-1</sup> as compared to rest of the doses. Application of pyribenzoxim @ 30 g ha<sup>-1</sup> found more remunerative followed by pyribenzoxim @ 35 g ha<sup>-1</sup> as both received higher values of NMR(Rs. 11084 and Rs. 10604 ha<sup>-1</sup> and B:C ratio (1.38 and 1.36) respectively.

**Rajul Soni**  
Signature of the student

**Dr. Rajendra Prasad Sahu**  
Signature of the Advisor

## CURRICULUM VITAE

**Name of Author- Miss. Rajul Soni**

**Place- Jabalpur, Madhya Pradesh**

**Date of Birth- 25<sup>th</sup> September 1991**



The author of this thesis Miss. Rajul Soni, D/o Mr. Yashwant Kumar Soni and Mrs. Lalita Soni was born on 25<sup>th</sup> September 1991 at Narayanganj, Mandla (Madhya Pradesh). She has joined the following institutions and successfully completed the degree of M.Sc. (Ag.) during the year 2017-18 with 7.70GPA with 10 point scale.

S.No	Institutions
1	JNKVV, Jabalpur 2018
2	JNKVV, Jabalpur 2016
3	Govt. High School Narayanganj, Mandla
4	Excellance School Narayanganj, Mandla

She has got the following degrees,

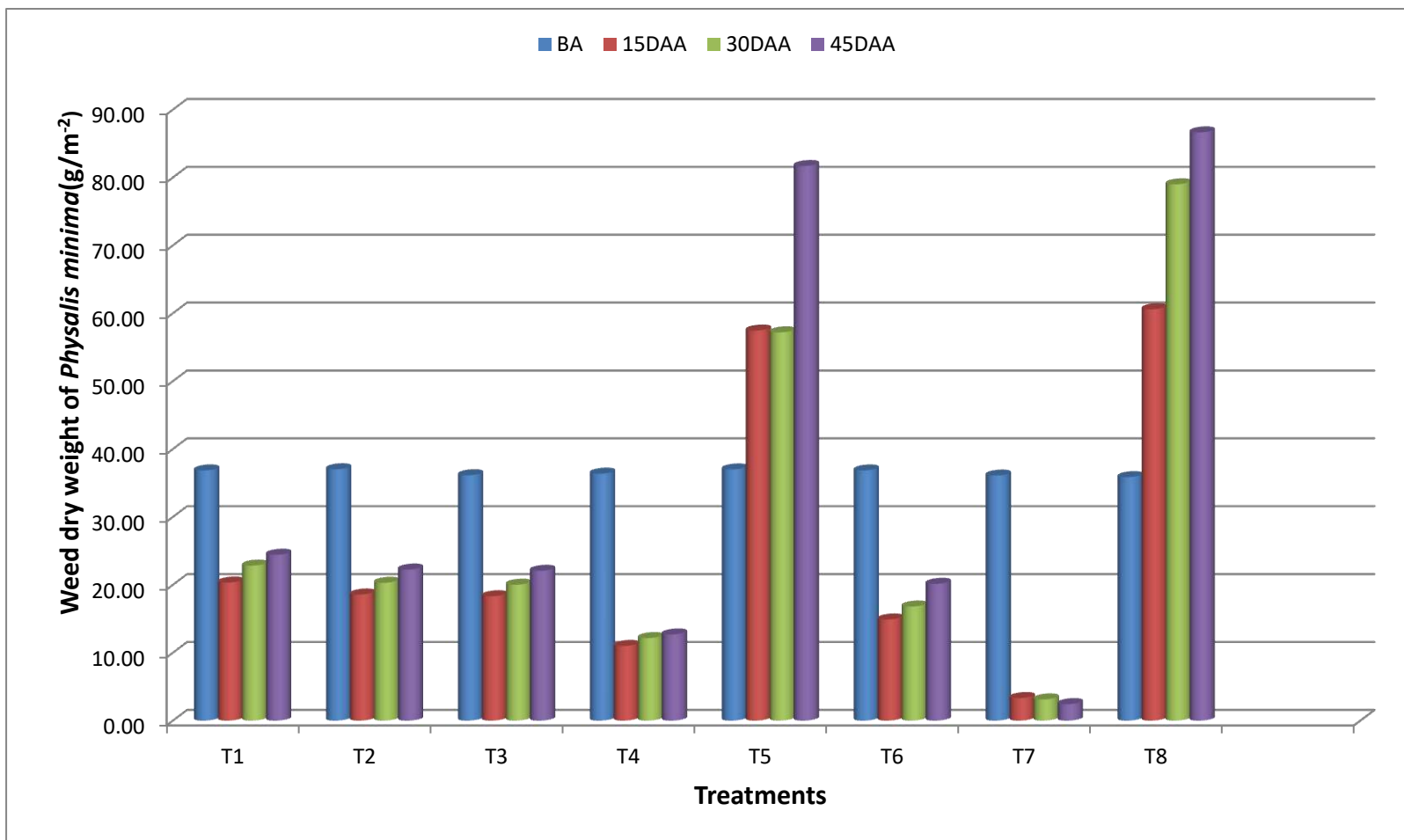
S.No.	Degree granted	University/Board	Year
1.	M.Sc. (Ag.)	JNKVV, Jabalpur	2018
2.	B.Sc. (Ag.)	JNKVV, Jabalpur	2016
3.	12 <sup>th</sup>	Govt. High School Narayanganj, Mandla	2007
4.	10 <sup>th</sup>	Excellence School Narayanganj, Mandla	2009

She has the following scientific interests-

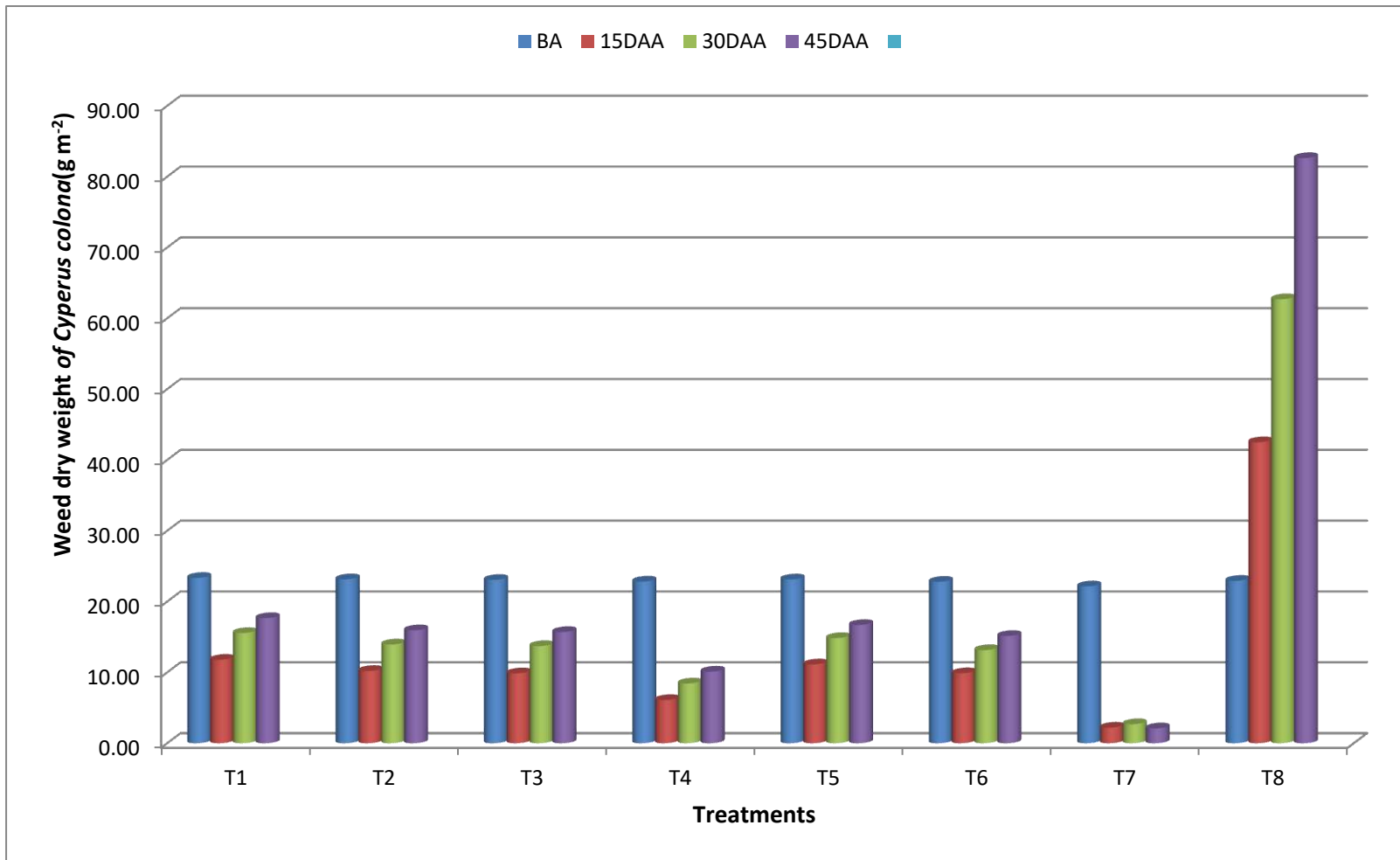
### Scientific interests

- a. Agronomy
- b. Research work on Weed Management

For the partial fulfillment of the master's degree programme she was allotted a research problem on "Evaluation of post emergence application of pyribenzoxim against weeds in direct seeded rice under Kymore Plateau and Satpura Hills" which was successfully conducted by her and being submitted in the form of the thesis.



**Fig. 4.2(e): Influence of different treatments on dry weight of *Physalis minima* in direct seeded rice**



**Fig. 4.3(c): Influence of different treatments on dry weight of *Cyperus rotundus* in direct seeded rice**

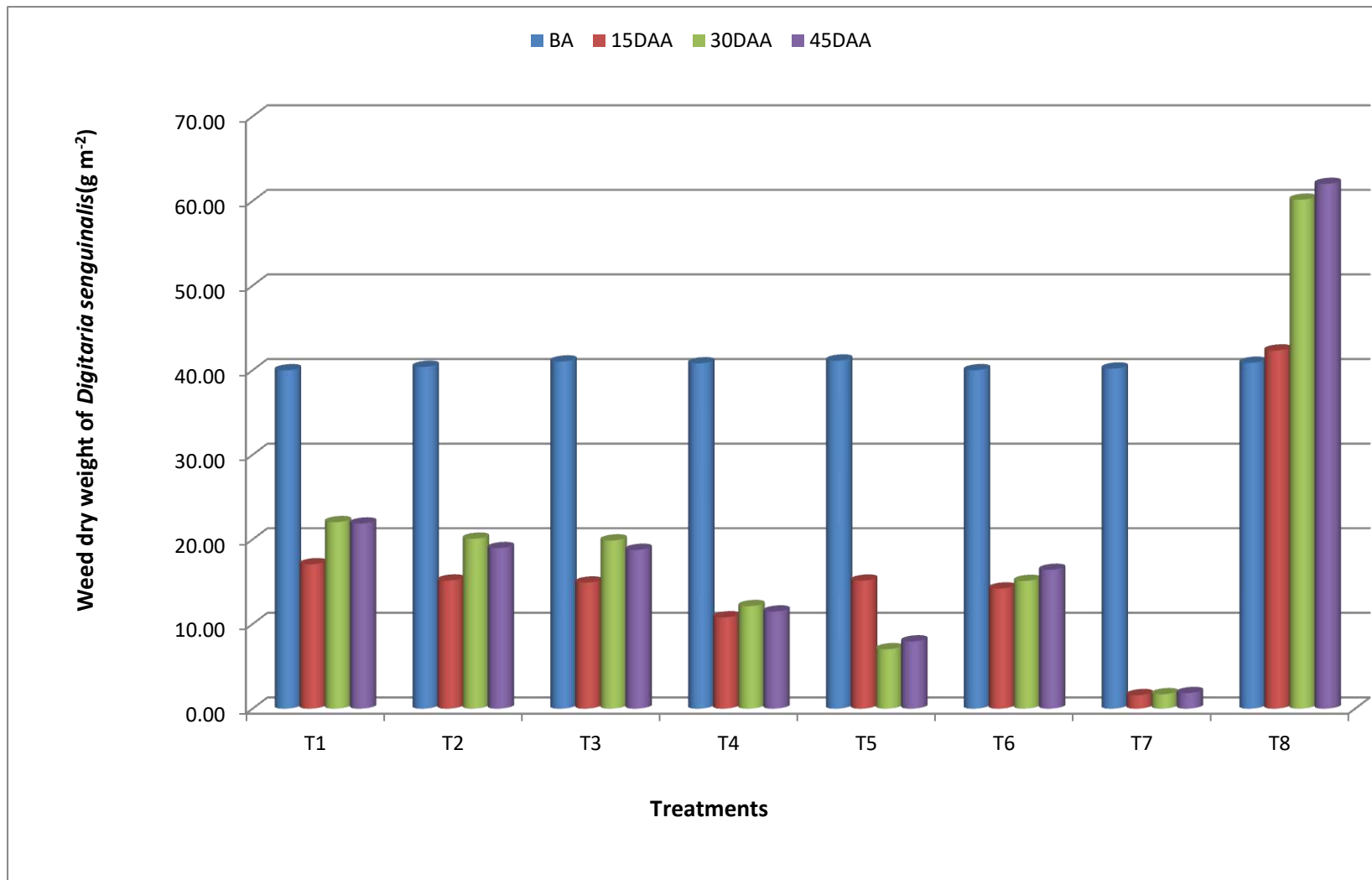


Fig. 4.3(b) Influence of different treatments on dry weight of *Digitaria sanguinalis* in direct seeded rice

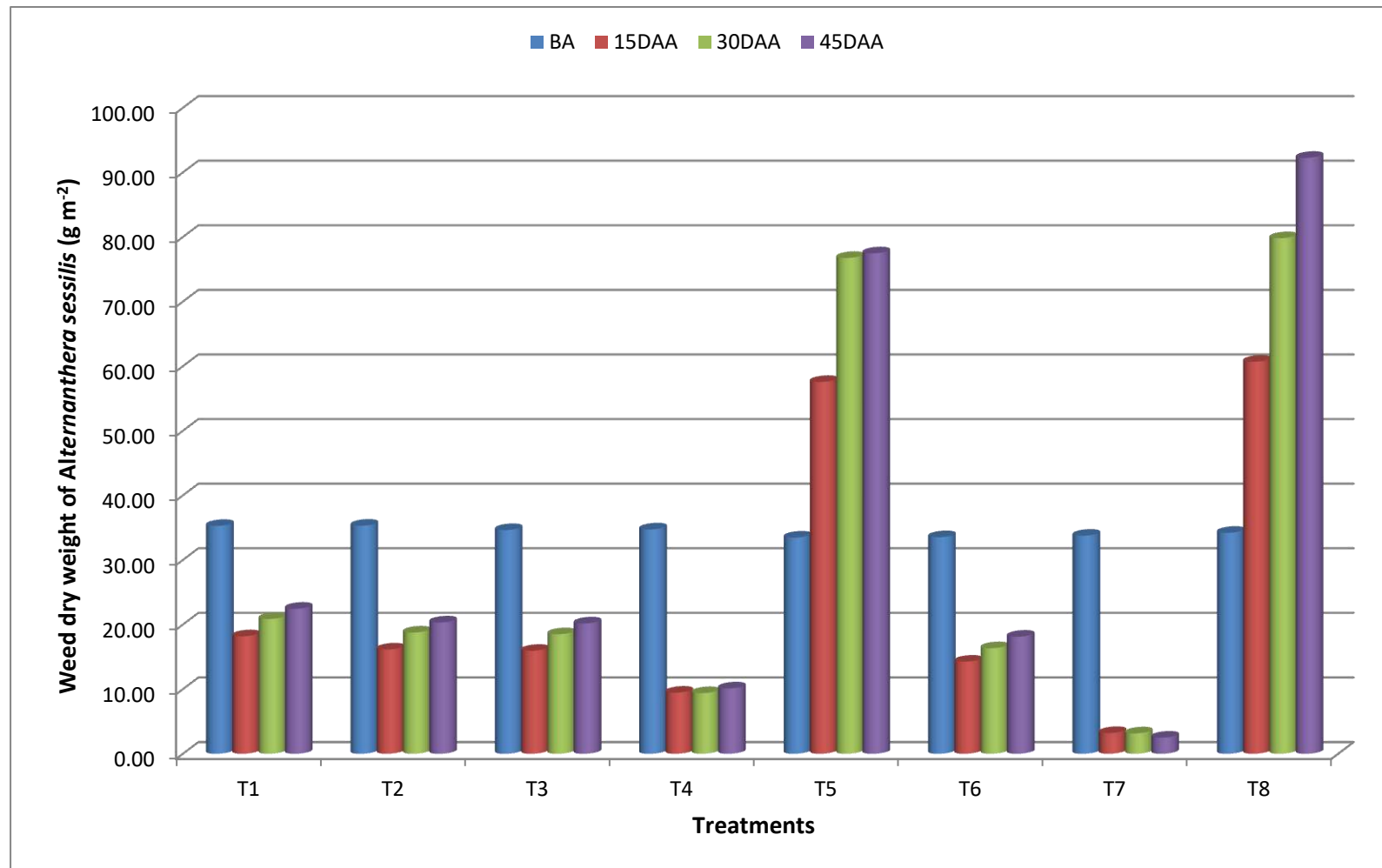
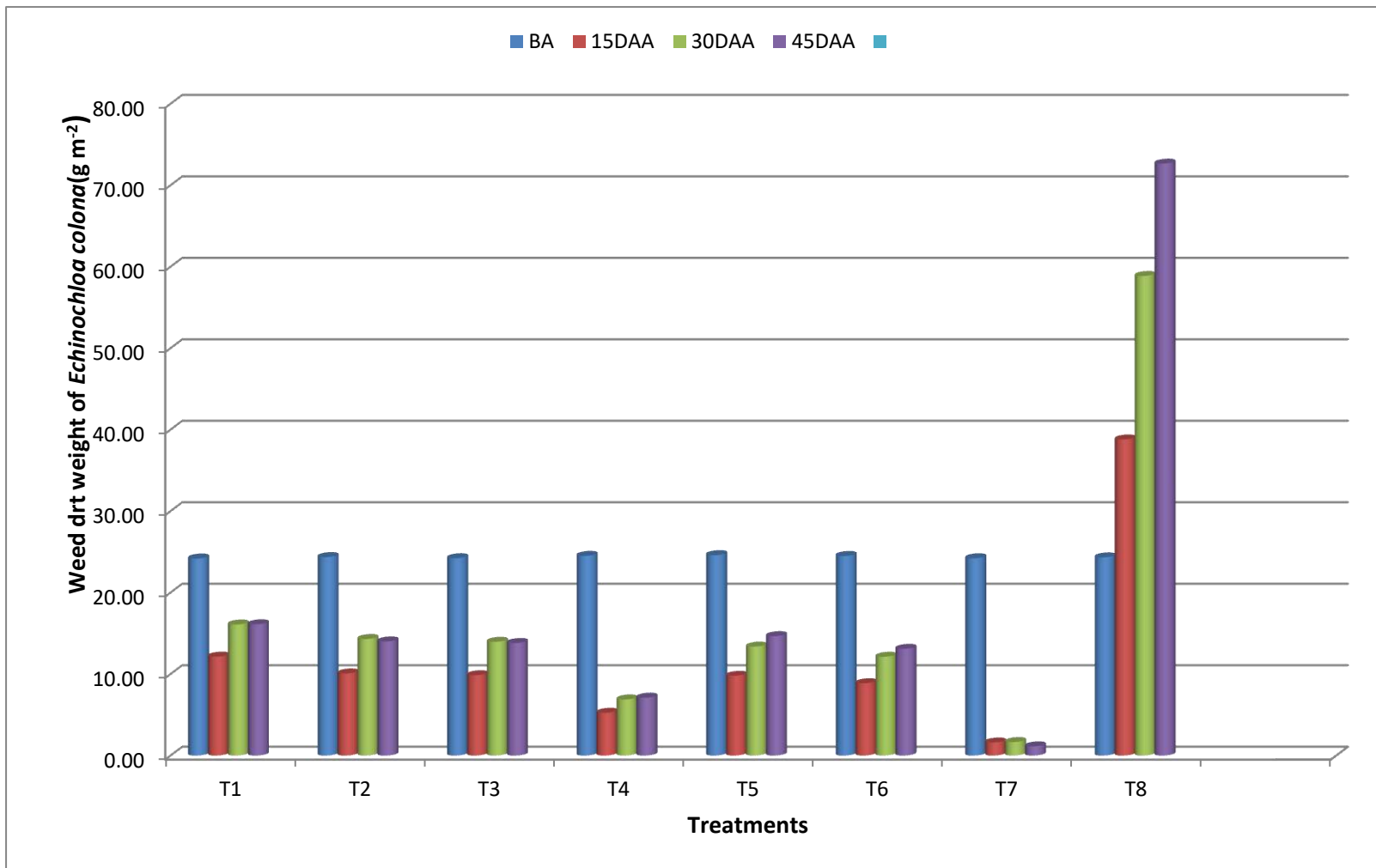
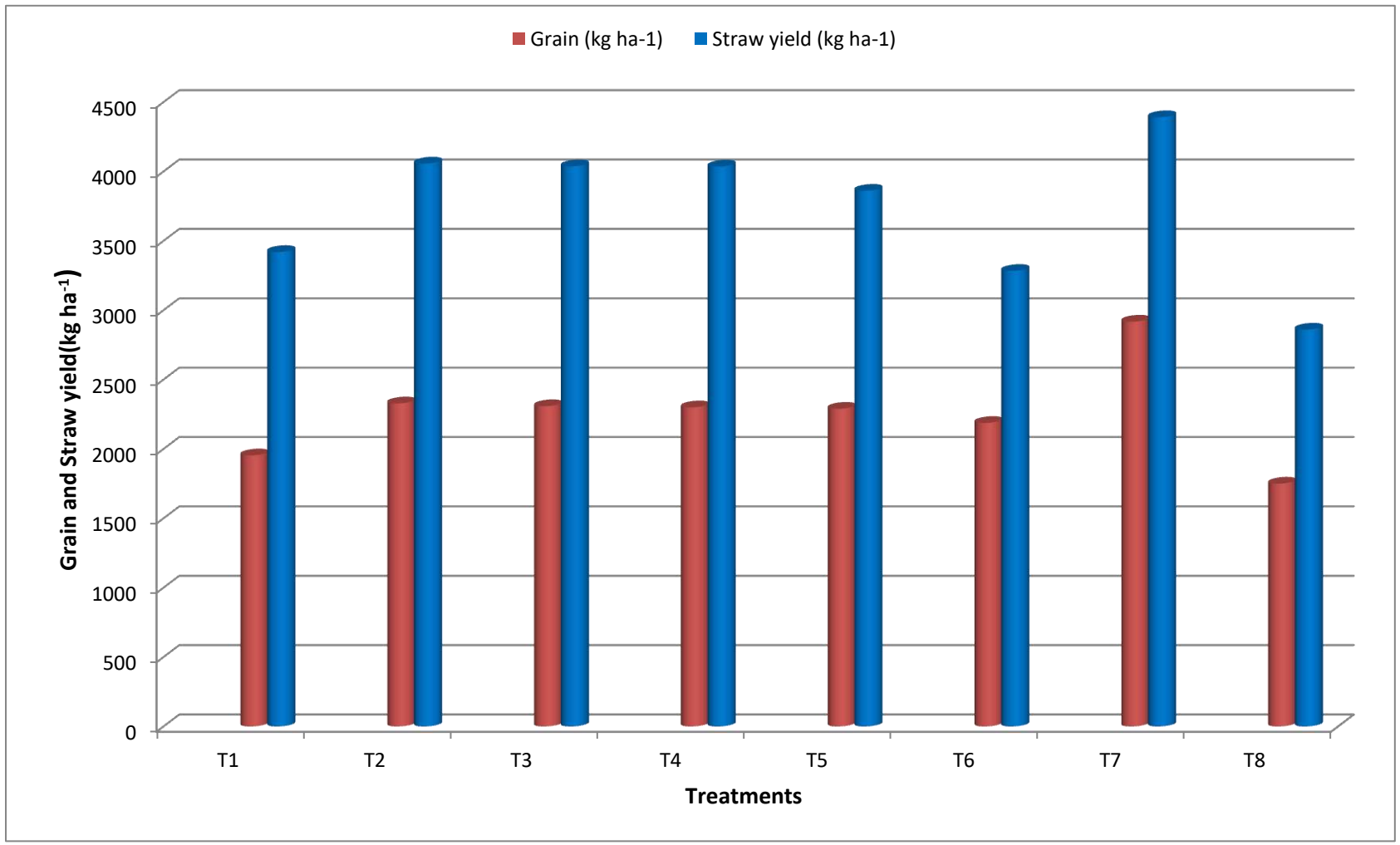


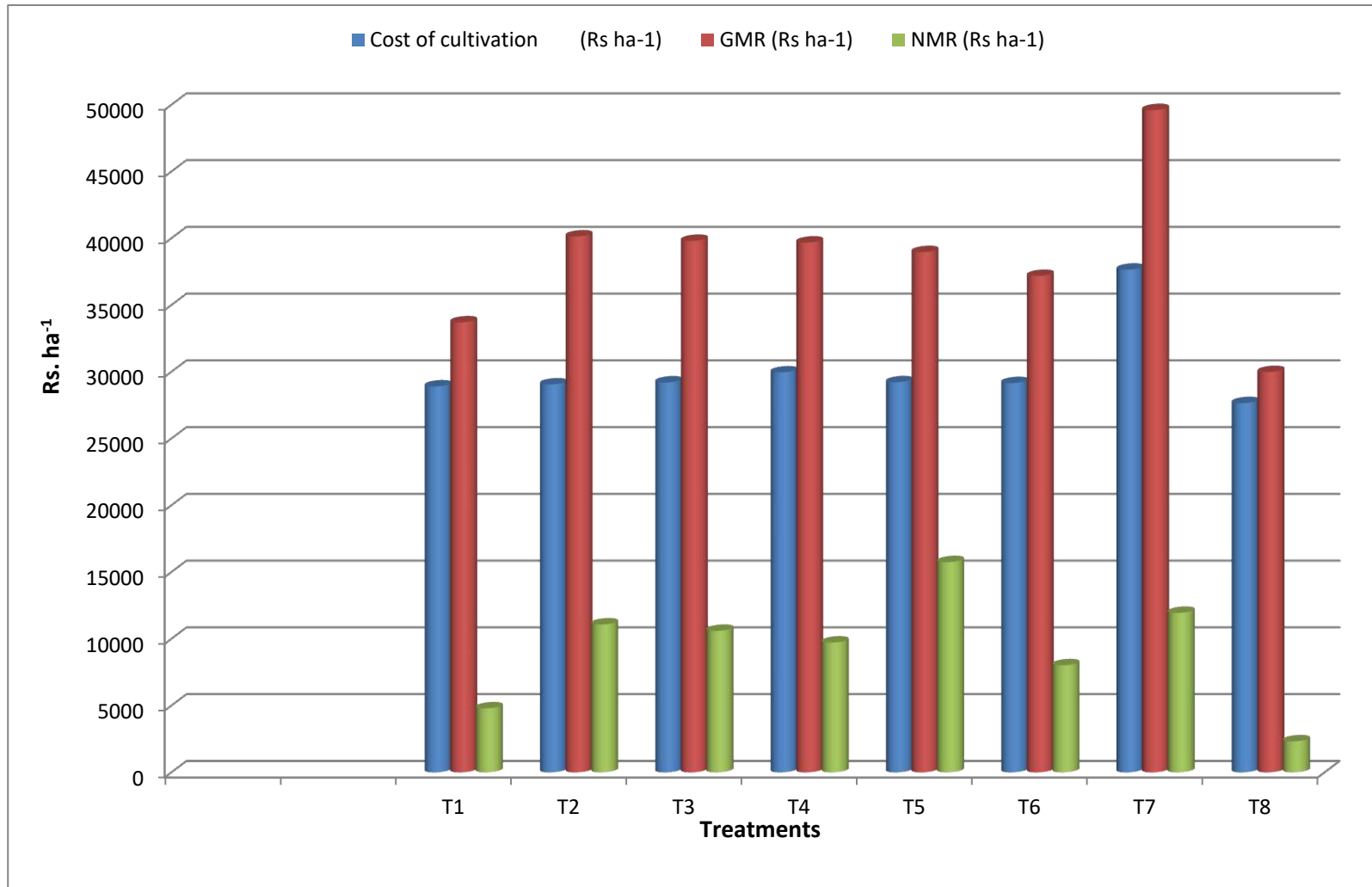
Fig. 4.3(d): Influence of different treatments on dry weight of *Alternanthera sessilis* in direct seeded rice



**Fig. 4.3(a):** Influence of different treatments on dry weight of *Echinochloa colona* in direct seeded rice



**Fig. 4.6: Influence of different treatments on grain and yield of direct seeded rice**



**Fig. 4.8: Economics analysis of different treatments in direct seeded rice**

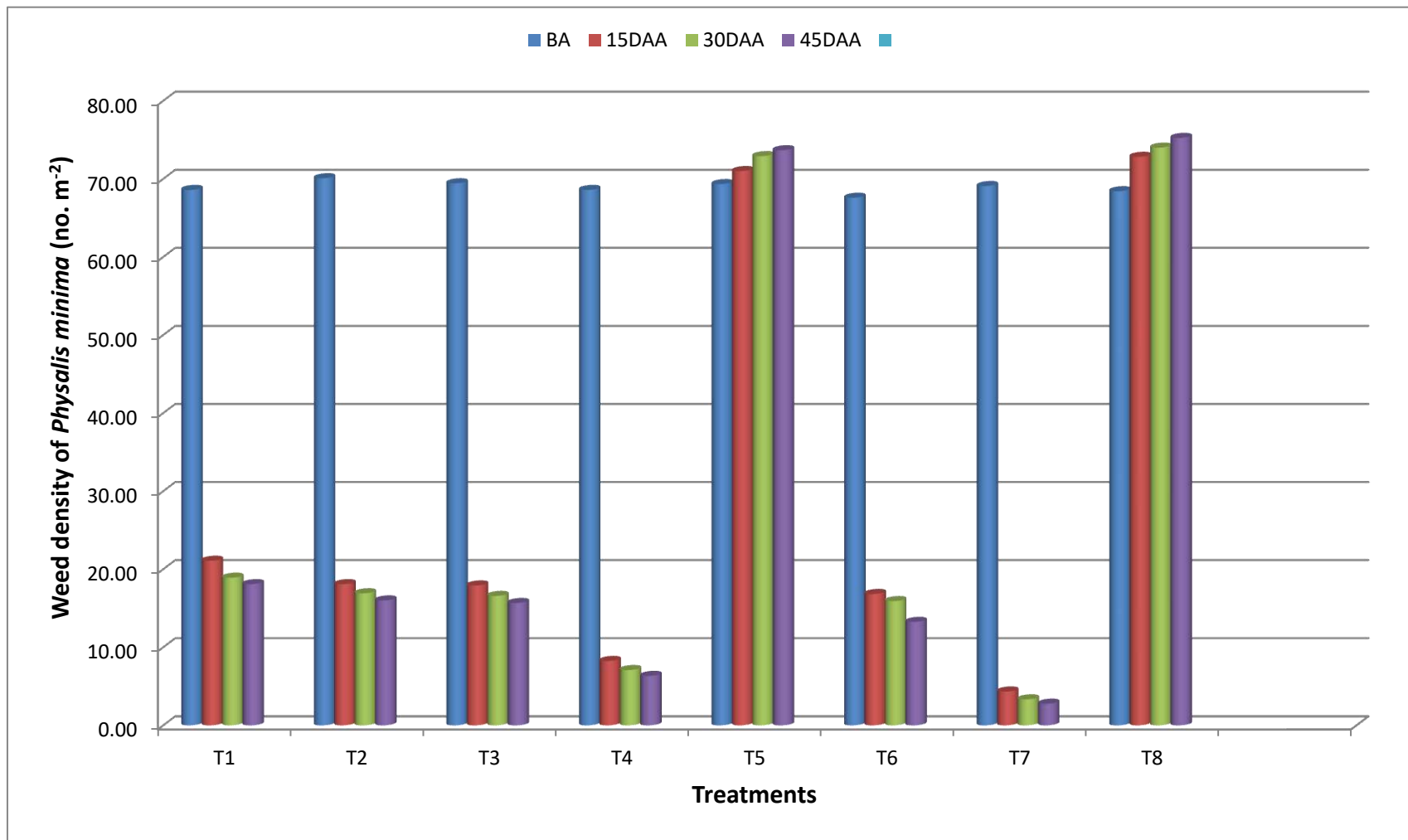
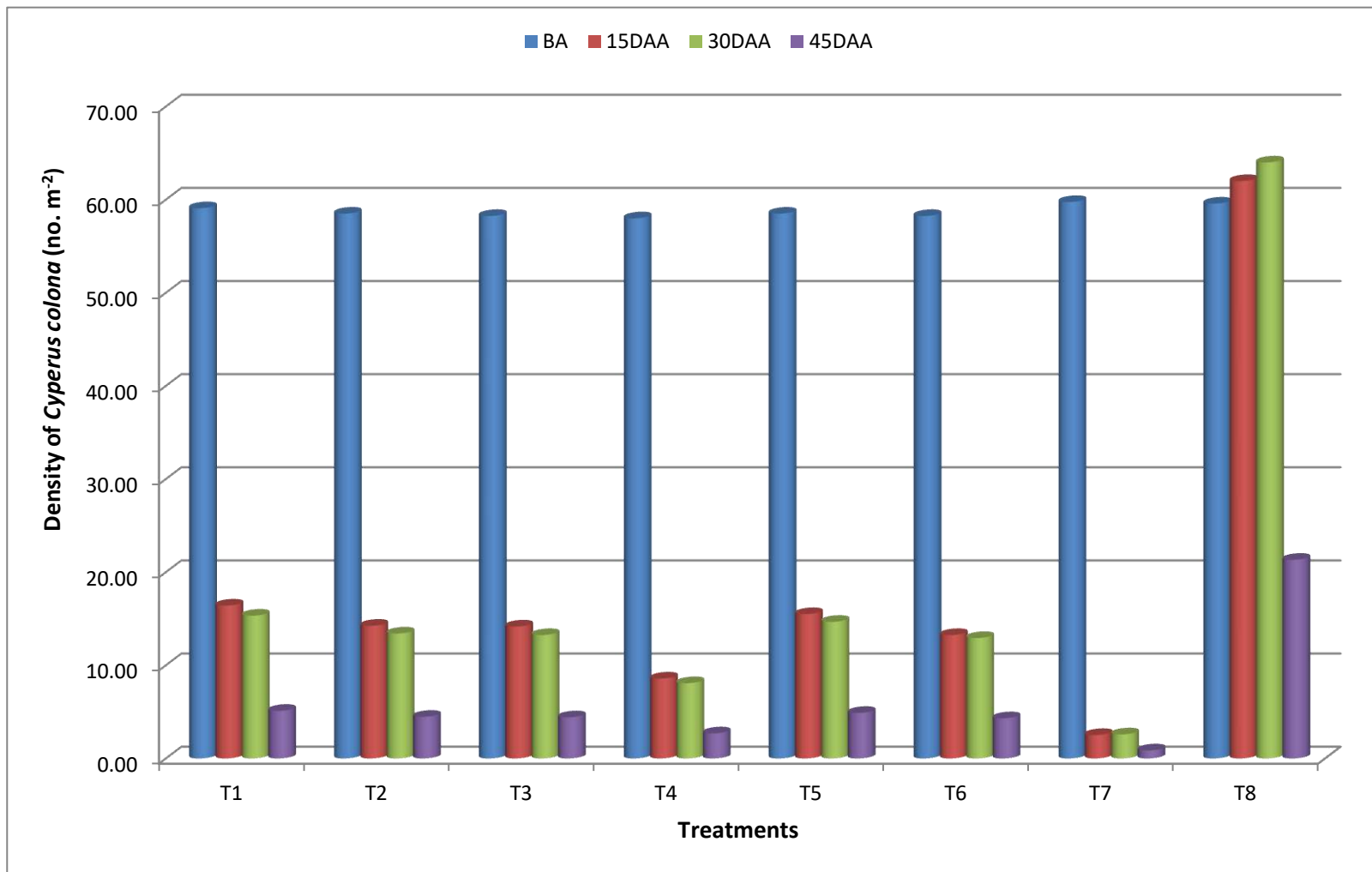
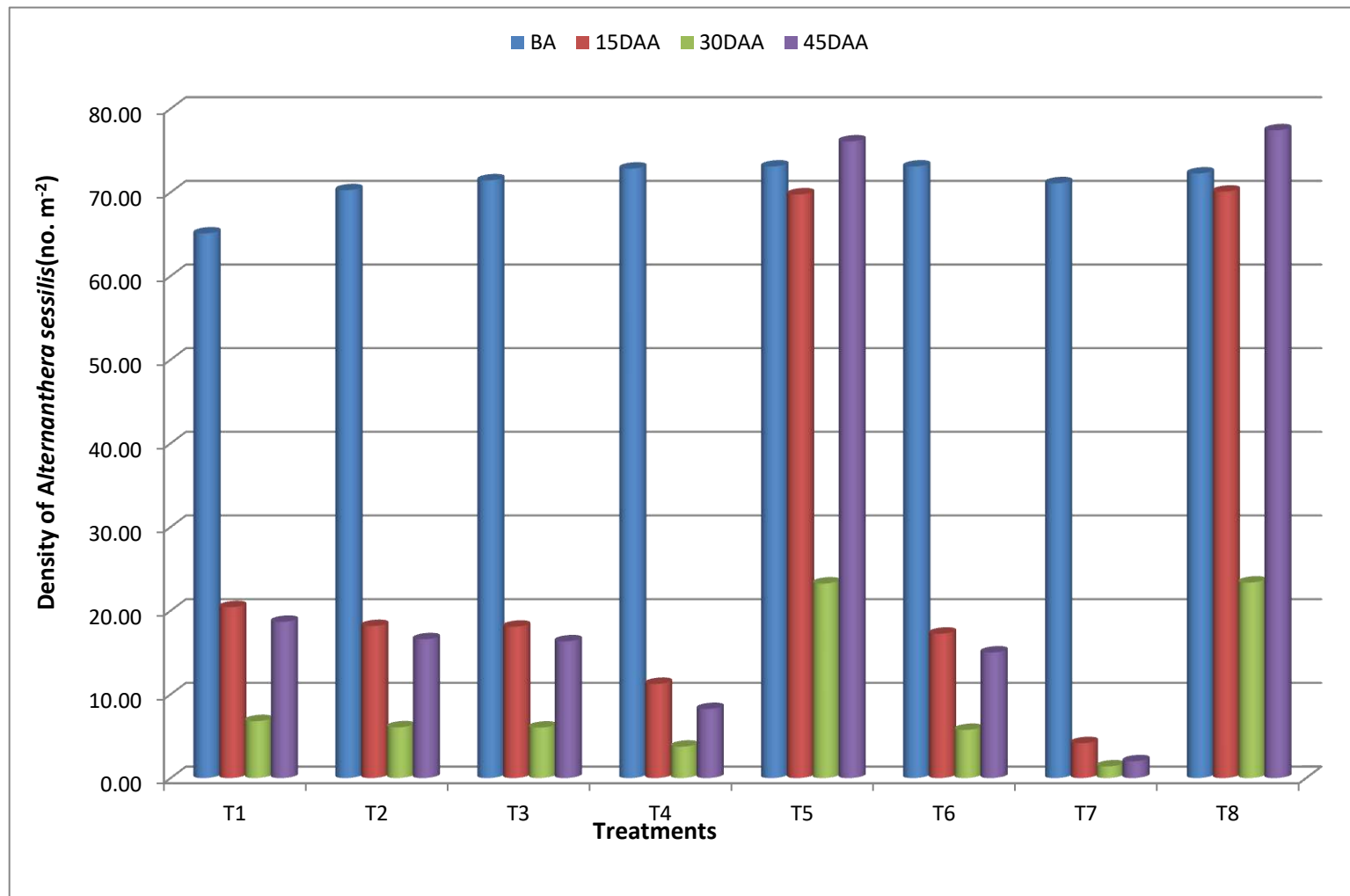


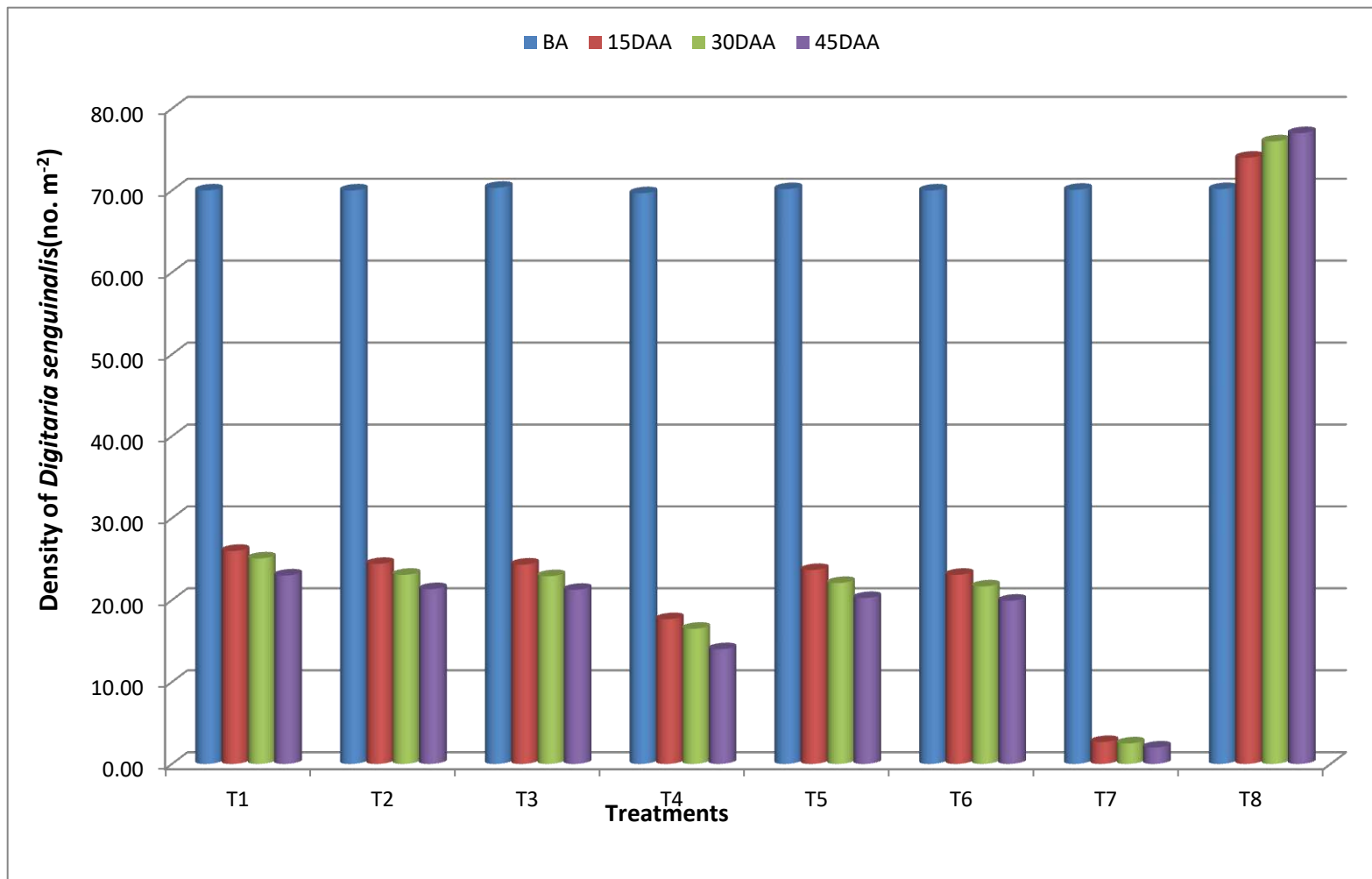
Fig. 4.2(e): Influence of different treatments on density of *Physalis minima* in direct seeded rice



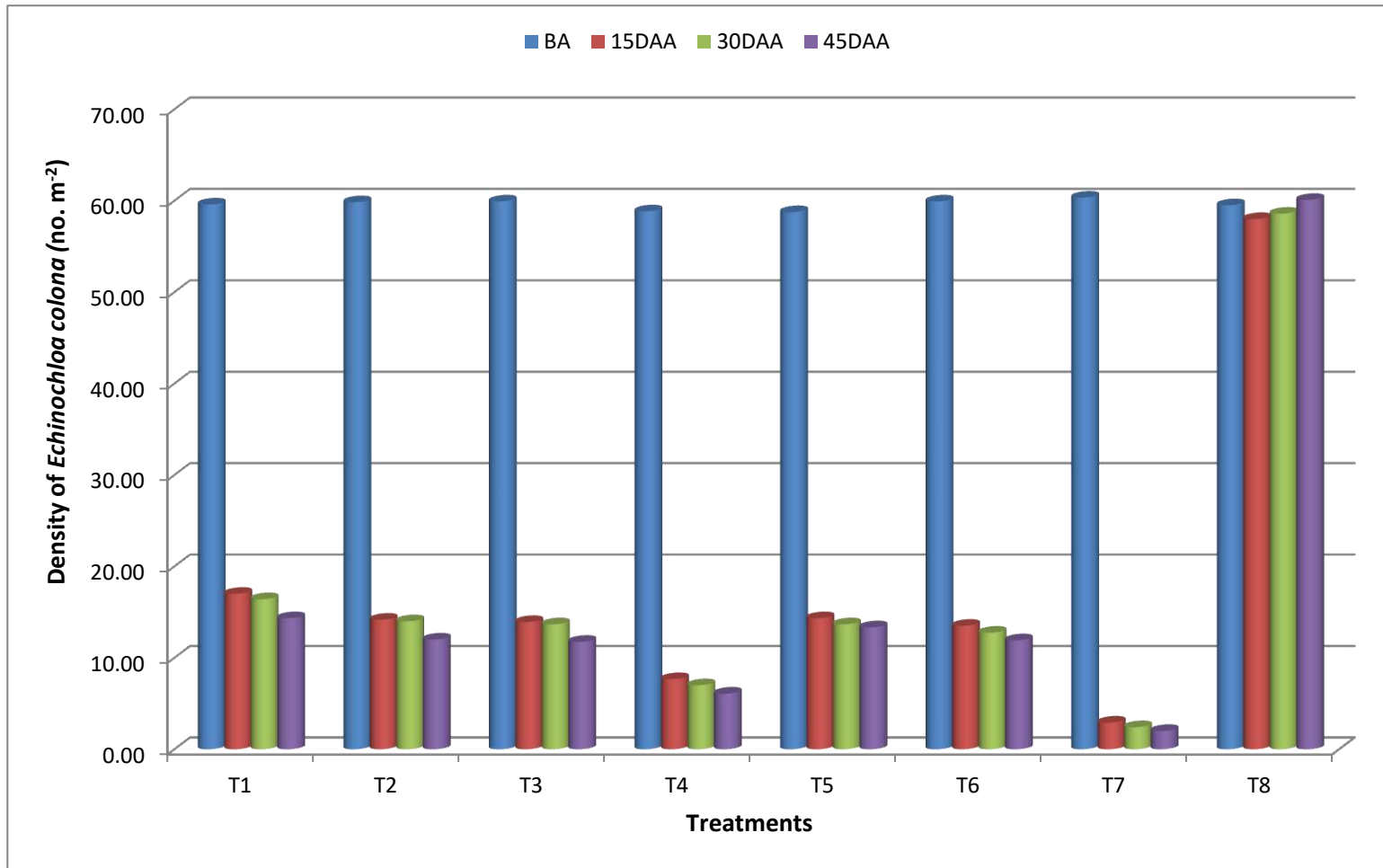
**Fig. 4.2(c): Influence of different treatments on density of *Cyperus rotundus* in direct seeded rice**



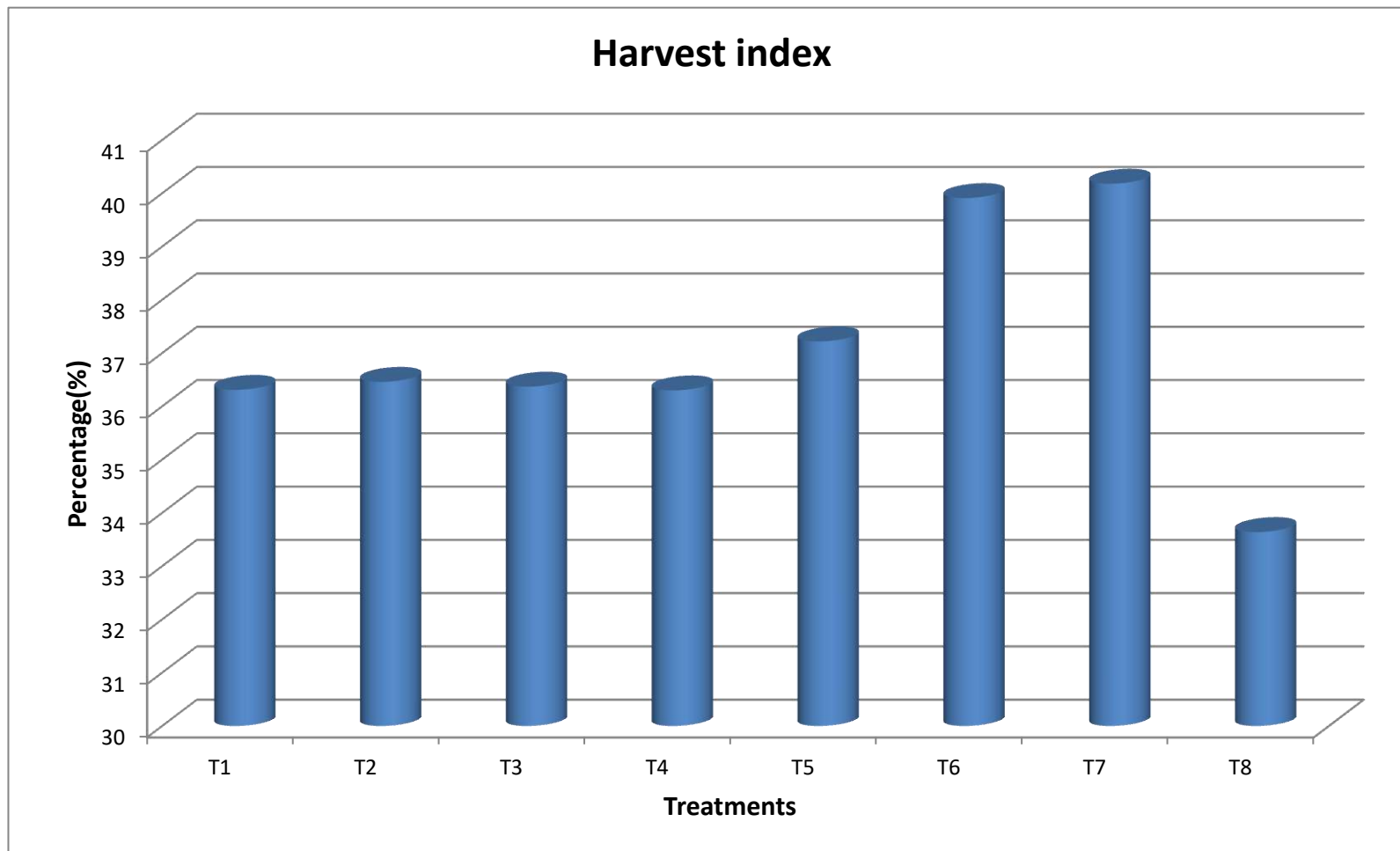
**Fig. 4.2(d): Influence of different treatments on density of *Alternanthera sessilis* in direct seeded rice**



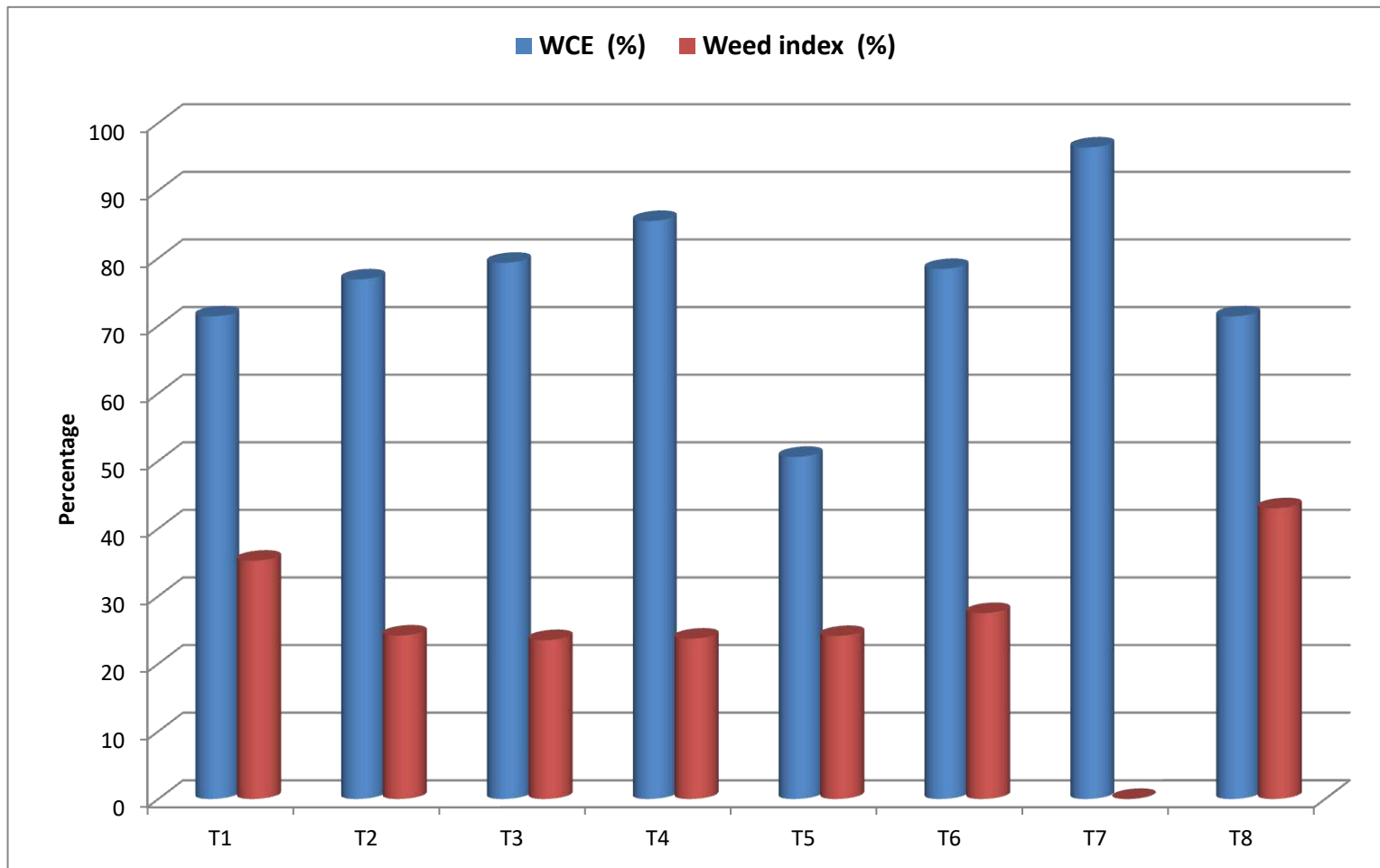
**Fig. 4.2(b): Influence of different treatments on density of *Digitaria sanguinalis* in direct seeded rice**



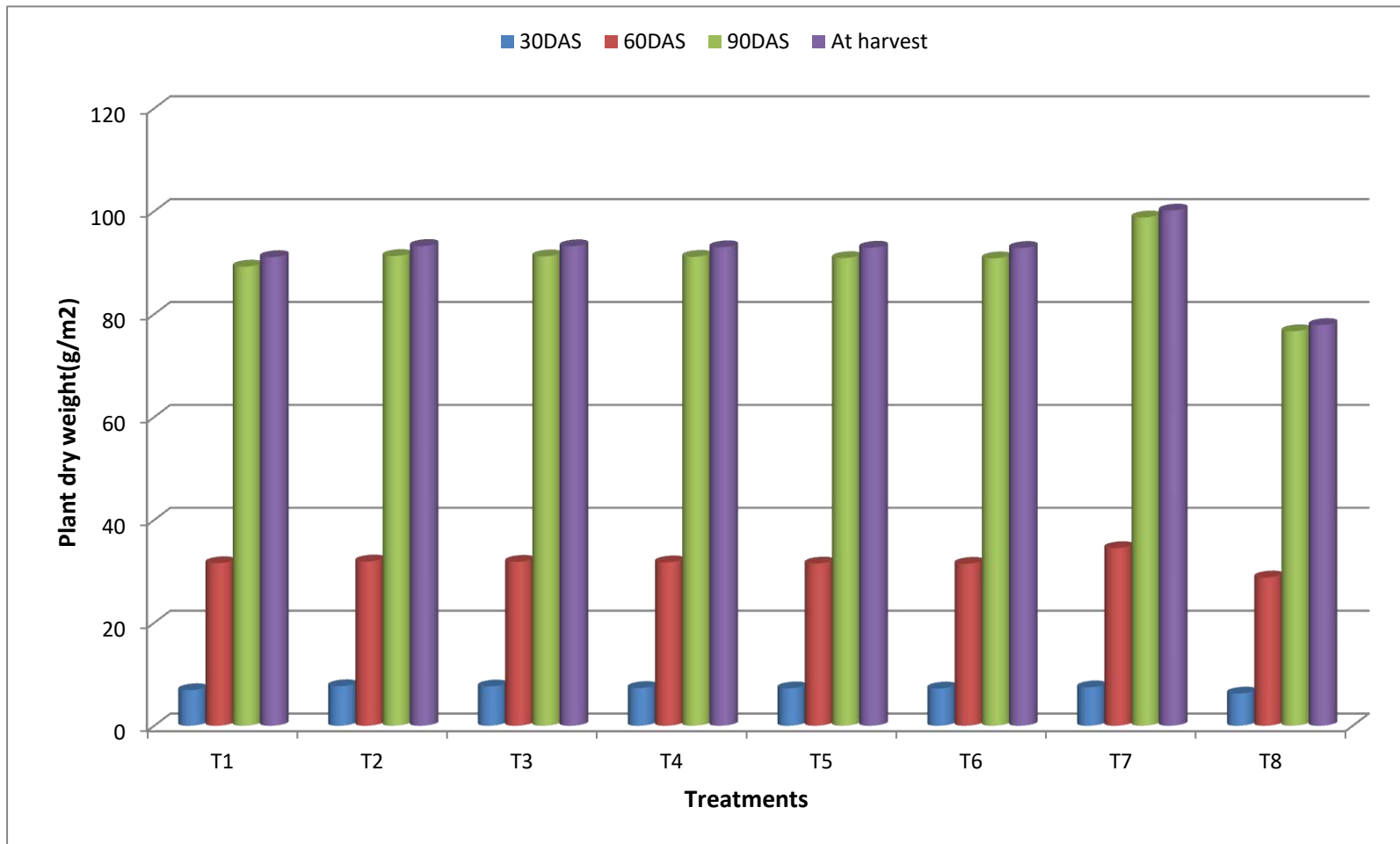
**Fig. 4.2(a): Influence of different treatments on density of *Echinochloa colona* in direct seeded rice**



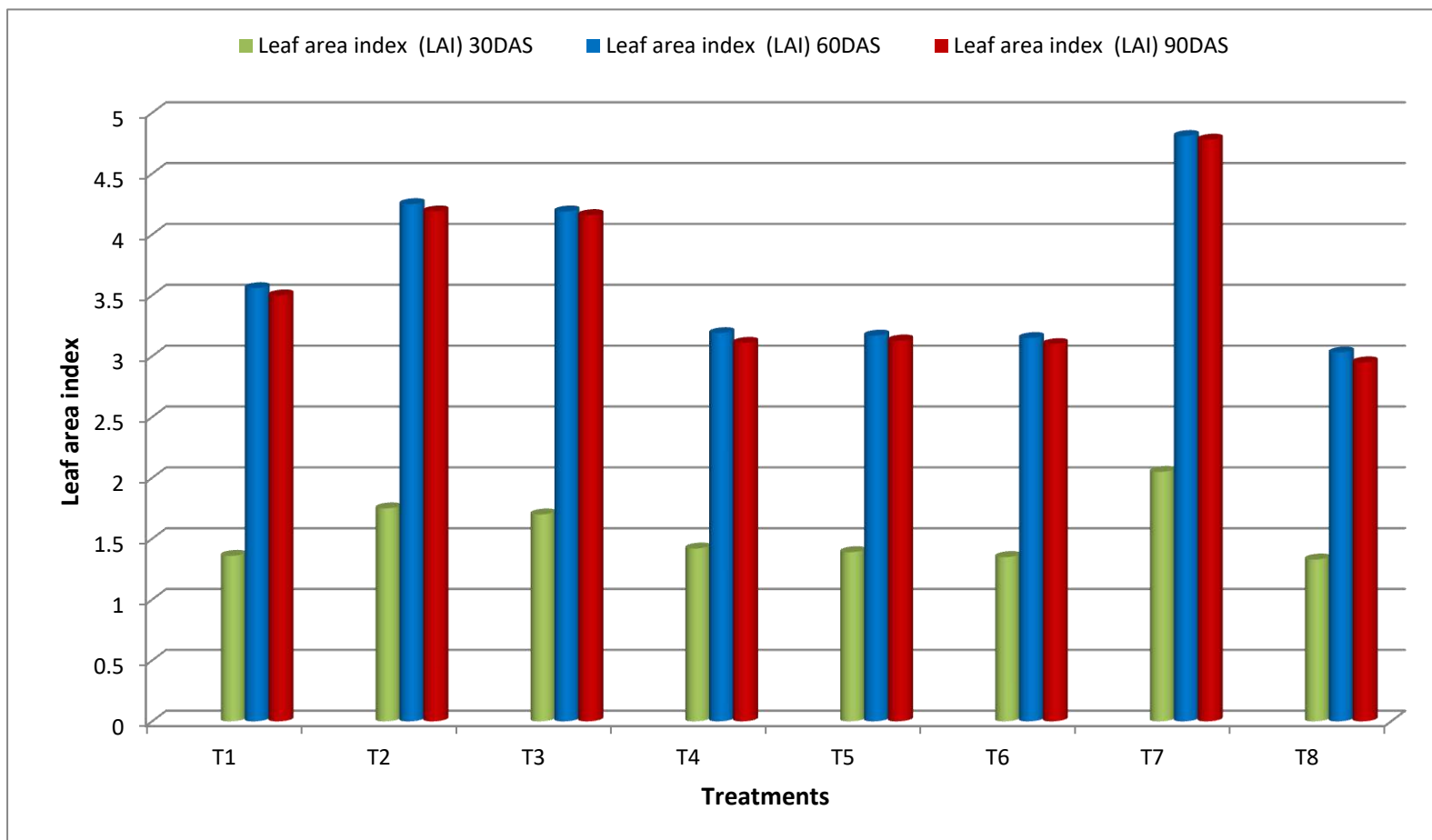
**Fig. 4.7: Influence of different treatments on harvest index of direct seeded rice**



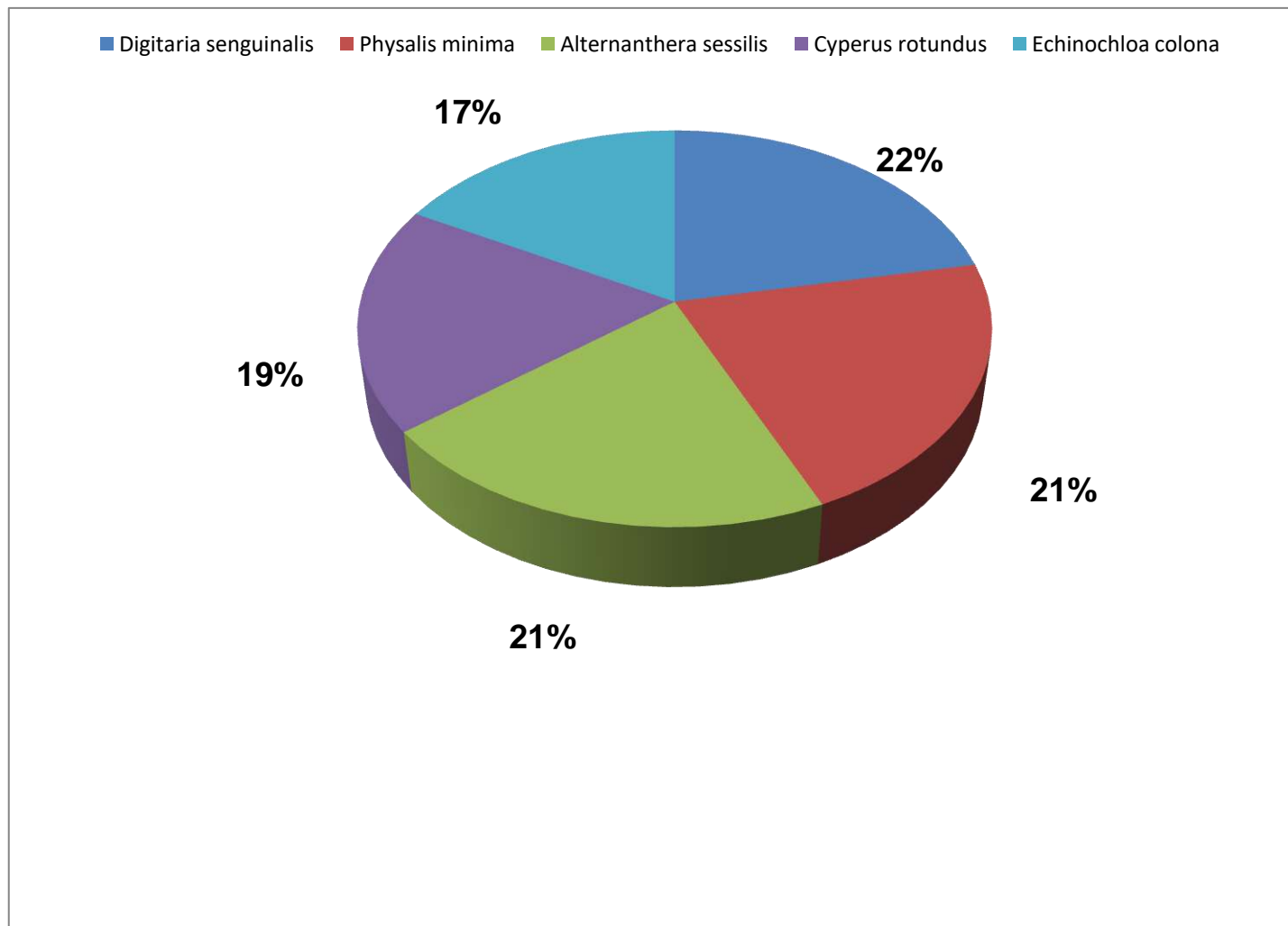
**Fig. 4.4(a): Influence of different treatments at 30 DAA on weed control efficiency and weed index in direct seeded rice**



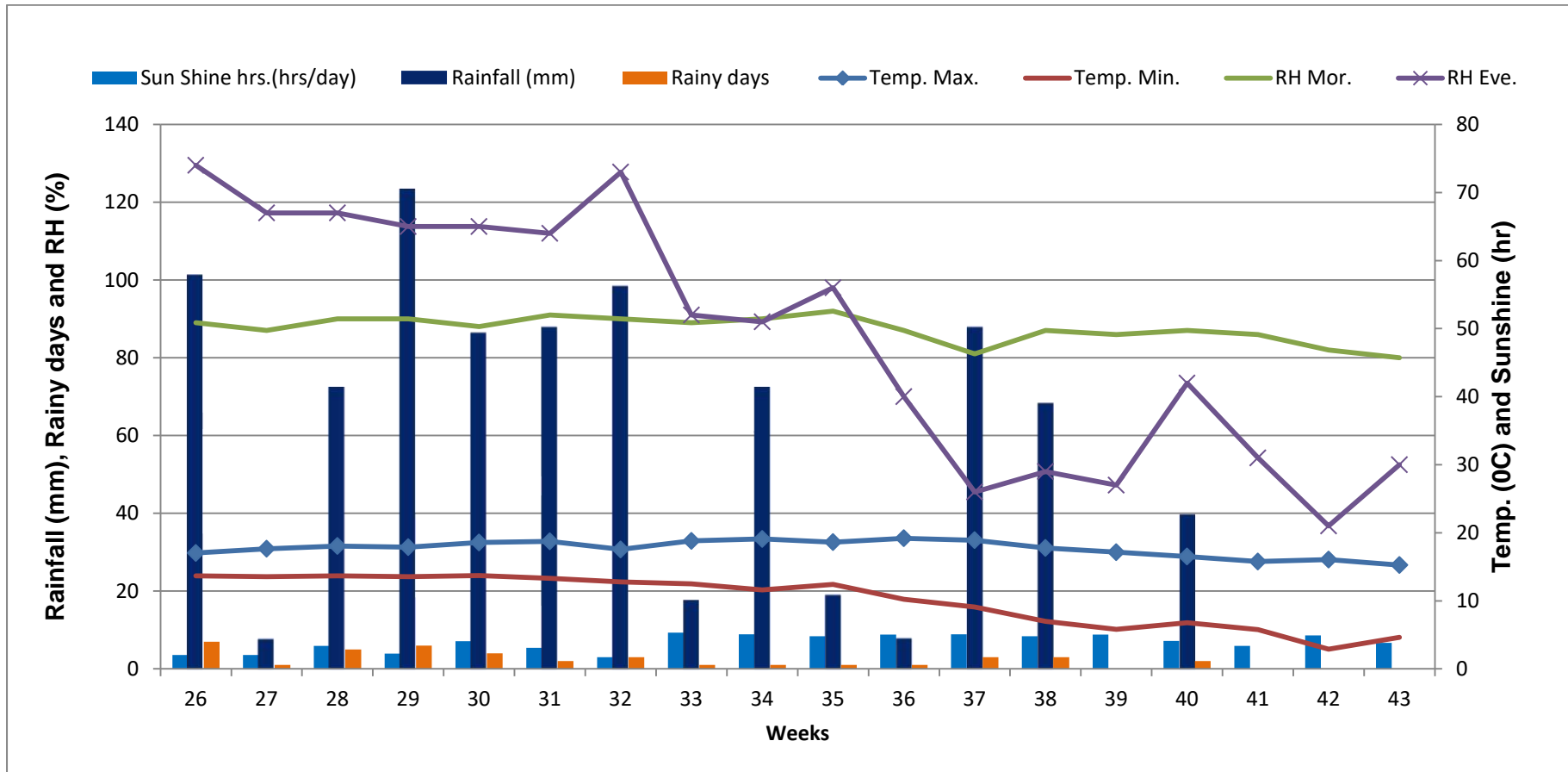
**Fig. 4.4(b): Influence of different treatments at different days interval on dry weight in direct seeded rice**



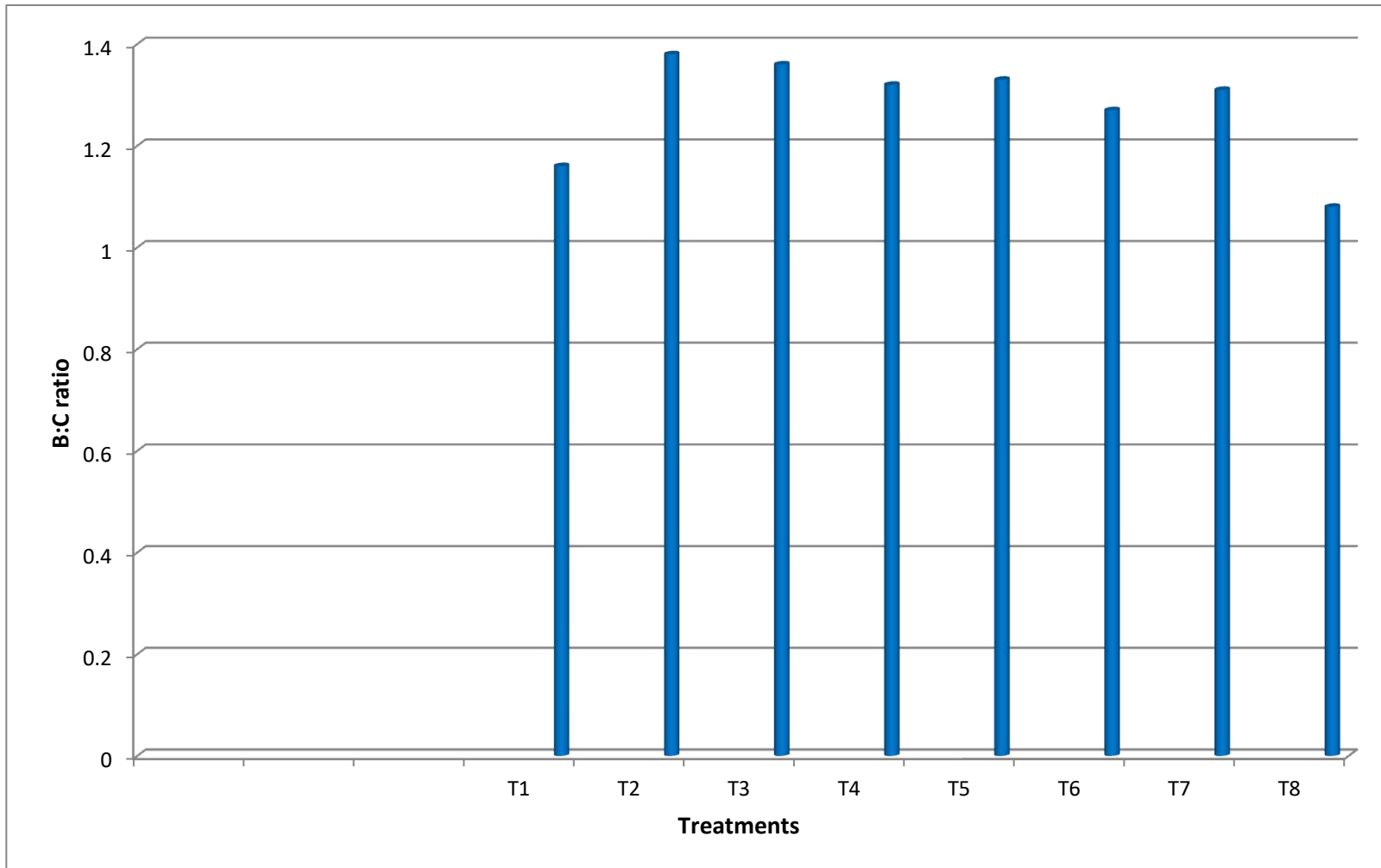
**Fig. 4.5: Influence of different treatments at different days interval on leaf area index in direct seeded rice**



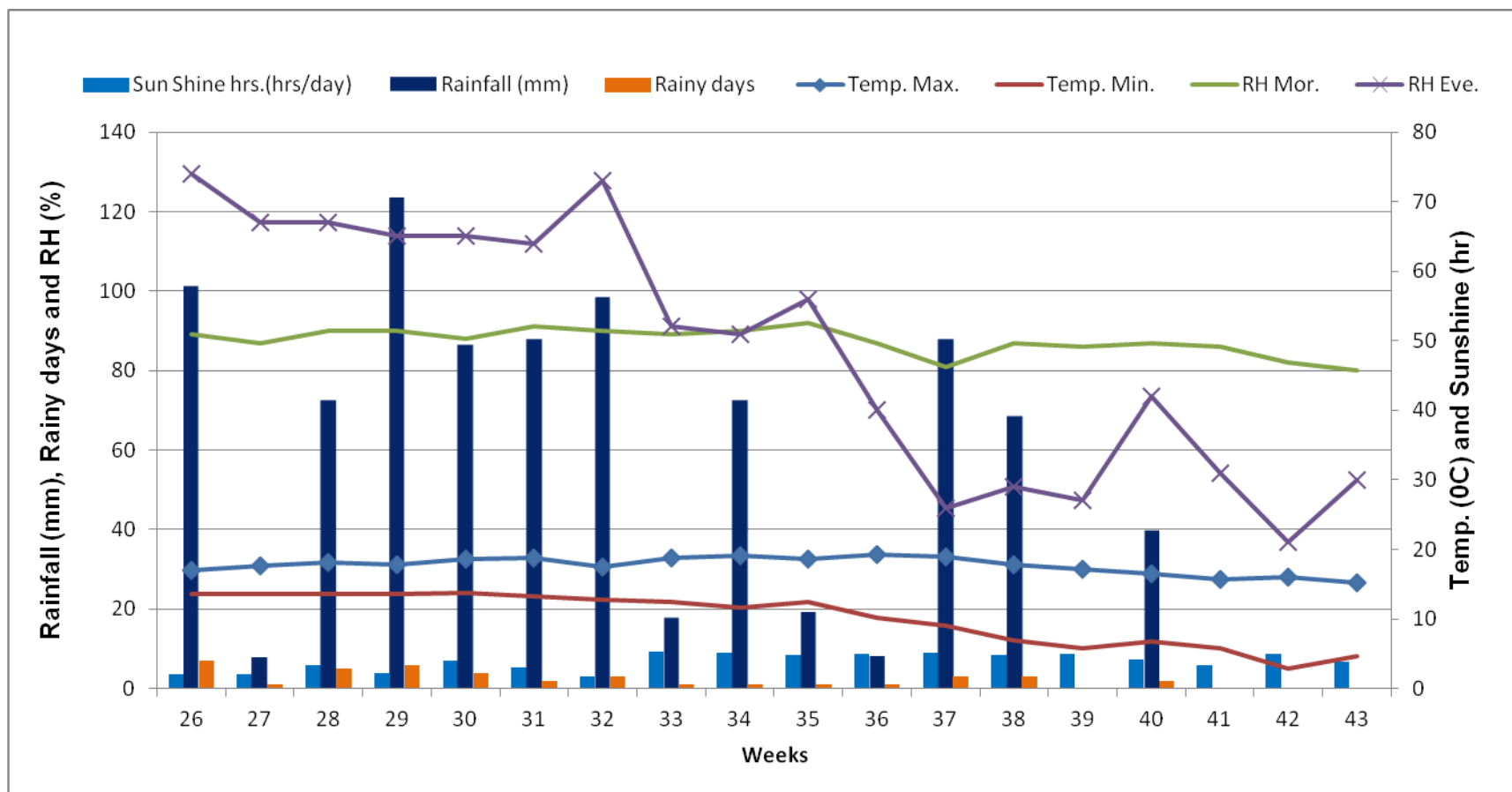
**Fig. 4.1: Species wise weed density before application at 15, 30 and 45 DAA and relative density in weedy check plots**



**Fig.3.1: Weekly meteorological parameters during crop season (July to Oct. 2017)**



**Fig. 4.9: Influence of different treatments on benefit-cost ratio**



**Fig.1. Weekly meteorological parameters during crop season (July to Oct. 2017)**

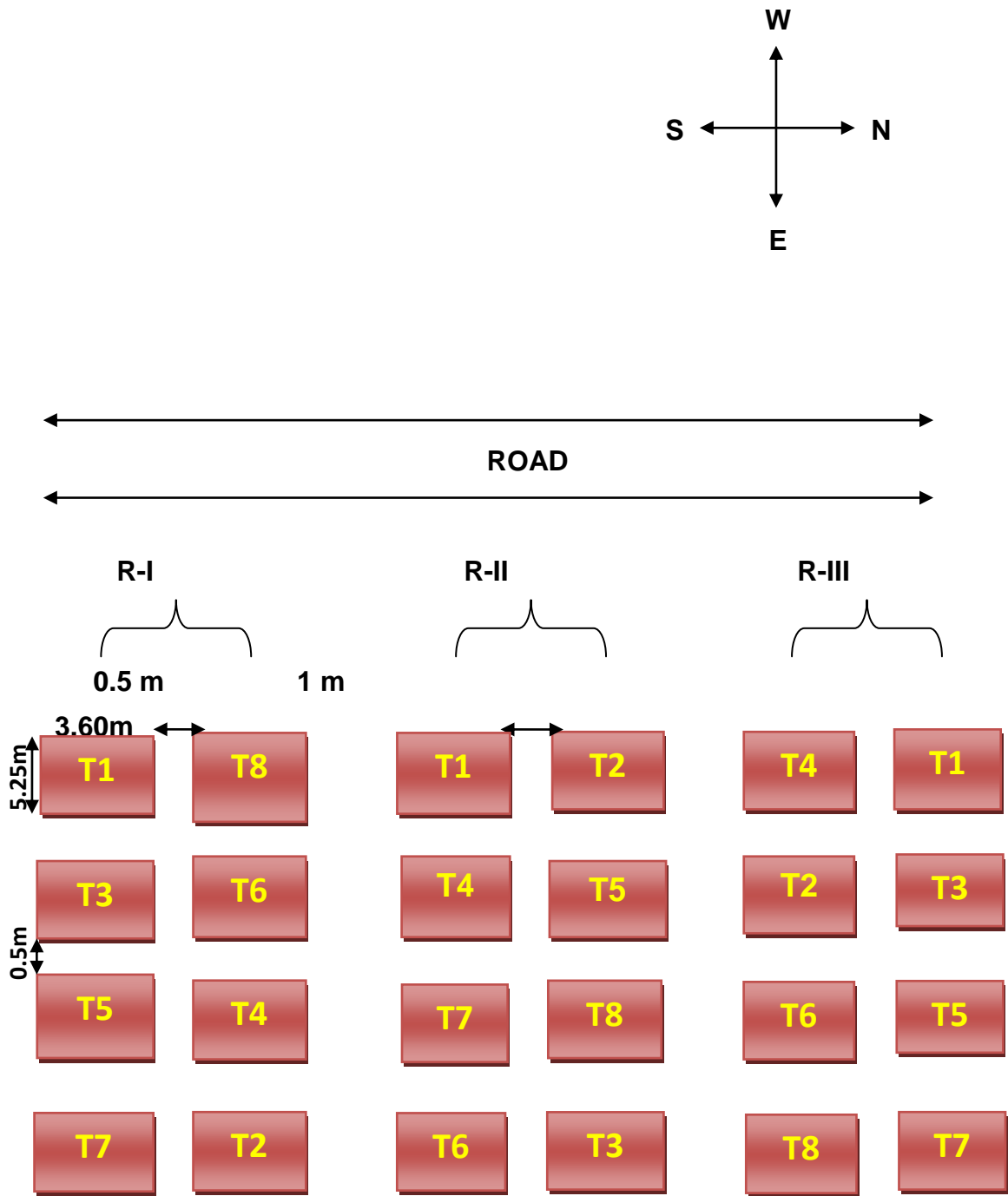


Fig. 3.2 Experimental details of Layout plan



**Weedy check**



**Hand weeding**

**Plate-1: Weedy check and hand weedy plots.**



**Fenoxaprop-p-ethyl 56.95 g/ha**



**Oxadiargly 100 g/ha**

**Plate-4: Effect of check herbicides against weeds in direct seeded rice**



**Pyribenzoxim 25 g/ha**



**Pyribenzoxim 30 g/ha**

**Plate-2: Effect of pyribenzoxim as post emergence against weeds in direct seeded rice**



**Pyribenzoxim 35 g/ha**



**Pyribenzoxim 60 g/ha**

**Plate-3: Effect of pyribenzoxim as post emergence against weeds in direct seeded rice**