

**COMPATIBILITY OF MULTINUTRIENT MIX
SAMPOORNA WITH HERBICIDES FOR RICE**

By

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2024**

**COMPATIBILITY OF MULTINUTRIENT MIX SAMPOORNA
WITH HERBICIDES FOR RICE**

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THESIS

*Submitted in partial fulfillment of the
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**DEPARTMENT OF AGRONOMY
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VELLANIKKARA, THRISSUR- 680 656
KERALA, INDIA
2024**

DECLARATION

I, hereby declare that this thesis entitled “**Compatibility of multinutrient mix Sampoorna with herbicides for rice**” is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis, for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis, entitled “**Compatibility of multinutrient mix Sampoorna with herbicides for rice**” is a record of research work done independently by **Mrs. Akhila P. (2021-11-016)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.



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INTRODUCTION

1. INTRODUCTION

Weed infestation is one of the major constraints in rice cultivation. Weed flora in rice ecosystem is diverse and includes grasses, sedges and broad leaf weeds. Manual weeding is a tedious process that requires considerable time and labour. Herbicidal weed control is very common in rice as it is the economically viable and easy method. Post emergence herbicide sprays are recommended during the period of 15-20 days after transplanting. This application window coincides with the time of foliar application of nutrients. Spraying cost has to be met by the farmer for herbicide application as well as foliar nutrient supplementation, when done separately as per the present recommendation.

Tank mixing of agrochemicals is a common practise among farmers in order to save labour, time and application cost. The practice of mixing agrochemicals or similar products in spray tank, shortly before application is known as tank mixing and it reduces cost and facilitates easiness in handling. However, most of the time mixing is done without having a scientific knowledge on effect of tank mixing. Tank mixing of agrochemicals may result in synergistic, antagonistic, or neutral effects on efficacies of chemicals involved. Random mixing of agrochemicals can also cause physical and chemical incompatibilities leading to antagonistic effects which may result in crop injury or other undesirable results. Hence scientific information regarding compatibility of nutrient-herbicide combinations is required for standardising the tank mix combinations.

Agrochemical use in agriculture leads to high costs hence spray combinations of different products are a viable option, economically. Synergistic effects of some tank mixed combinations used in pest control were noted by Li *et al.* (2019). Mixing with nutrient solutions can also enhance efficacy of plant protection chemicals by way of better absorption. On sunflower, tank mix application of boron with herbicides was effective in avoiding boron deficiency along with controlling weeds (Castro *et al.*, 2002). Studies show that addition of urea in spray solution can enhance the absorption of herbicides and thus herbicide

efficacy. Reddy *et al.* (2021) reported that tank mixing with urea enhanced weed control efficiency of herbicides: bispyribac sodium and cyhalofop butyl + penoxsulam (pre-mix) compared to their application without urea in rice.

Sampoorna KAU multimix is a multinutrient formulation of Kerala Agricultural University recommended for foliar application. It contains Mg, S, B, Zn, Cu, Fe, Mn, and Mo and crop specific mixtures are available for rice, banana and vegetables. In rice, it is recommended to apply as foliar spray at nursery, tillering and panicle initiation stages (30 & 50 DAT). So there is a scope for combining first spray of Sampoorna along with post emergence herbicide application if it is done by 20-25 days after transplanting. There is no information on compatibility of herbicides with “Sampoorna”.

The use of Sampoorna is becoming popular among rice farmers hence there is a need to study the compatibility of Sampoorna with commonly used rice herbicides. Hence, with the above perspectives the current research programme entitled “Compatibility of multinutrient mix Sampoorna with herbicides for rice” was undertaken with the objective of evaluation of weed control efficiency and compatibility of tank mix application of Sampoorna multinutrient mix (rice) of KAU with post emergence herbicides in rice, so that an economically viable recommendation can be generated for the benefit of farming community.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The weed spectra in rice consist of grasses, sedges as well as broad leaf weeds. Farmers apply various types of herbicides to manage weed flora in rice. This includes graminicides, broad spectrum herbicides, and herbicides effective against sedges and broad leaf weeds *etc.* Regardless of the chemical makeup or type of formulation, farmers combine herbicides to increase the range of control of weed population. This, in many cases results in loss of activity of the pesticides over the targeted pest or weed population. Tank mixing has several advantages, but in order to get the right results, it needs to be done correctly. The procedure may be expensive, time-consuming, and problematic if done in an unscientific manner. Scientific and prior knowledge on the compatibility of distinct chemical combinations is required for obtaining best results from tank mixing. Tank mixed application of fertilizers with herbicides can be done to save labour and time. The possible interactions between various chemical combinations have to be studied and evaluated. Scientific information on herbicide interactions can help to develop effective combination sprays, an efficient and practically feasible strategy in weed management. As studies pertaining to tank mixing of herbicides with nutrient solutions are very scanty, studies on tank mixing of various herbicides are also reviewed in this chapter.

2.1. TANK MIX HERBICIDE COMBINATIONS FOR WEED MANAGEMENT IN VARIOUS CROPS

2.1.1. Additive/ Synergistic effects of tank mixed herbicides

a) Studies in rice

Jordan *et al.* (1995) conducted field experiments and concluded that tank mixed combination of fenoxaprop-ethyl and bensulfuron, when applied prior to flooding is found to effectively manage diverse weed flora in rice. Herbicide mixture of fenoxaprop at 0.075 kg/ ha and propanil plus molinate at 2.52 + 2.52 kg ai/ ha was found to be compatible and resulted in 98% control of barnyard grass.

The study indicates the compatibility of herbicide mixture of Bentazon with fenoxaprop at 0.075 kg/ ha, which brought about 91% control of barnyard grass in rice (Zhang *et al.*, 2005).

Teja *et al.* (2016) recorded significantly less weed count of *Echinochloa colona* and *Paspalum scrobiculatum* at 50 DAT in rice with the application of ethoxysulfuron at 15g + fenoxaprop-p-ethyl at 60g/ ha at 20 DAT which was on par with that of herbicide combination of azimsulfuron at 35g+ 2,4-D at 500gha⁻¹. According to the study zero weed density was recorded for *Ludwigia parviflora* when applied with the herbicide combination of azimsulfuron at 35g+ 2,4-D at 500g/ ha, which was followed by combinations of pretilachlor at 750g+ pyrazosulfuron-ethyl at 25 g/ ha and ethoxysulfuron at 15g+ fenoxaprop-p-ethyl at 60 g/ ha. The study also reveals that the combined application of pretilachlor at 750g+ pyrazosulfuron-ethyl at 25g/ ha effectively controlled *Cyperus iria* and recorded low weed dry weight and weed count which was followed by that of ethoxysulfuronat 15g + fenoxaprop- p-ethyl at 60g/ ha at 25 DAT.

According to Kaur *et al.* (2016), tank mix combination of bispyribac with ethoxysulfuron or chlorimuron + metsulfuron effectively controlled diverse weed flora in transplanted rice.

As per the findings of field experiment conducted by Atheena *et al.* (2017), in farmer's field at Alappad kole lands of Thrissur district in Kerala during september 2015 to january 2016, weed management of *Monochoria vaginalis* was successful with tank mixed combination of cyhalofop butyl with ethoxysulfuron. The study confirmed that tank mix combination of cyhalofop (80g/ ha) with pyrazosulfuron ethyl (30g/ ha) at 18 DAS effectively controlled diverse weed flora in wet seeded rice.

Tank mixed combination of fenoxaprop + ethoxysulfuron showed synergism and effectively controlled *Echinochloa* spp. Application of pendimethalin followed by bispyribac sodium+ ethoxysulfuron showed high efficiency in sedge and broad leaf weed control. Population of *Leptochloa chinensis* was reduced by 79 % and weed control efficiency of other grass weeds was improved by 12-20 % as compared to the sole application of pendimethalin (Kumar *et al.*, 2018).

Sekhar *et al.* (2020) evaluated different herbicide combinations for management of *Leptochloa chinensis* in wet seeded rice and concluded that tank mix application of bispyribac sodium with fenoxaprop-p-ethyl (at 25 + 60 g/ ha) or cyhalofop-butyl (at 25 + 80 g/ ha) resulted in least dry matter production of weeds, compared to the individual application of bispyribac sodium which resulted in lower weed control efficiency).

Reddy *et al.* (2021) reported that the herbicide mixture of cyhalofop butyl+ penoxsulam with chlorimuron ethyl+ metsulfuron methyl effectively managed *Echinochloa colona* and *Cyperus iria* in wet seeded rice and with the application of the above herbicide mixture higher rice grain yield was obtained which was greater than 100 % higher than that of unweeded control. As per the study tank mixing of fenoxaprop-p-ethyl with bispyribac sodium successfully managed *Echinochloa staginata* and *Cyperus iria* and the corresponding grain yield was 85 % more than that in the unweeded control.

b) Studies in other crops

Kaps and Odneal (1994) observed that tank mixing of oryzalin 3.4 kg/ ha with oxyfluorfen 1.1 kg/ ha or simazine 2.7 kg/ ha extended the days of weed control in vineyards compared to the individual applications of simazine or oxyfluorfen at full-label rates.

According to Singh (2009), carfentrazone when applied alone was found to be less effective against *Canada thistle*, while the tank mixed application of the same with glyphosate imposed greater damage to the weed in *Saccharum munjo* field.

Yadav *et al.* (2010) evaluated the efficacy of tank mixed herbicide combinations against *Phalaris minor* in wheat and concluded that the herbicide combinations of half the recommended doses of clodinafop/ fenoxaprop/ pinoxaden were either on par or superior than their sole application. Half the recommended doses of sulfosulfuron with mesosulfuron+ iodosulfuron also showed similar trend compared to the individual application the herbicides. As per the findings of Paswan *et al.* (2012) metsulfuron-methyl when tank mixed with carfentrazone-ethyl (25-50 g/ ha) controlled all broad leaf weeds more efficiently and recorded higher wheat grain yield compared to their sole application.

Jhala *et al.* (2013) investigated the compatibility of tank mixed combinations of few herbicides and compared their efficacy with respect to their individual application. Results showed that glyphosate when tank mixed with sethoxydim effectively controlled barnyard grass and yellow foxtail (99%) while the individual application of glyphosate provided 90% and 91% control respectively for barnyard grass and yellow foxtail. The study revealed that tank mix application of pendimethalin with saflufenacil and sethoxydim controlled broad leaf and grass weeds in florida citrus more efficiently than the individual application or tank mix combination of the herbicides saflufenacil and sethoxydim.

A field experiment carried out at Indian Agricultural Research Institute during 2010 and 2011 by Younesabadi *et al.* (2014) revealed that pre-emergence application of pendimethalin 0.5 kg/ ha + imazethapyr 0.075 kg/ ha considerably reduced weed density and N, P and K uptake by weeds and significantly improved N, P, K uptake by soybean and soybean seed yield. According to study conducted by Underwood *et al.* (2017), tank mix application of glyphosate with dicamba caused synergism and controlled broad leaf weeds more efficiently than their individual application in glyphosate resistant soya bean.

Pre emergence application of tank mixed herbicide combinations of pendimethalin 0.75 kg/ ha + imazethapyr 0.050 kg/ ha and pendimethalin 0.75 kg/ ha + chlorimuron 0.006 kg/ ha was found to effectively suppress the infestation of *Cyperus rotundus*, and diverse broad leaf and grassy weeds in maize crop and

hence resulted in significant reduction in total dry matter content in comparison with that of weedy check (Susha *et al.*, 2014).

Hajebi *et al.* (2016) reported that pre-emergence application of tank mixed combination of pendimethalin 0.75 kg/ ha + imazethapyr 0.075 kg/ ha in chilli crop significantly decreased weed dry weight and weed density by 89% and 93% respectively and increased weed control efficiency by 86% compared to weedy check. As per the findings of Jha *et al.* (2015) tank mix combinations of pendimethalin with pyroxasulfone, acetochlor or dimethenamid-P improved corn yields and enhanced residual control of kochia weed in comparison to the sole application of pyroxasulfone or chloroacetamides.

A field experiment was conducted by Sudha *et al.* (2016) at Agricultural Research Station, Dharwad, Karnataka during *Rabi* season of 2014-15 and 2015-16 to assess the efficacy of premix herbicides and tank mix herbicides in wheat. Significant higher yield (4.31 t/ha) was obtained by tank mix application of sulfosulfuron+ metsulfuron 25 + 4 g/ ha and a higher yield of 4.15t/ha was obtained with the tank mix application of clodinafop+ metsulfuron 60 +4 g/ ha over weedy check. As per the findings of Yadav *et al.* (2016), tank mixing of metribuzin 105g/ ha with clodinafop 60 g/ ha, sulfosulfuron 25g/ ha or pinoxaden 50 g/ ha effectively controlled *Phalaris minor* (97-99%) and broad leaf weeds in wheat.

Sharma *et al.* (2018) evaluated the tank mix combinations of tembotrione and atrazine in *kharif* maize crop and the result shows that early post- emergence application of tembotrione at 80-100 g/ ha + stefes mero surfactant at 733 g/ ha + atrazine 500 g/ ha resulted in promising maize yield, high gross and net returns and high weed control efficiency. Highest green and dry fodder yields and lowest weed density and dry weight were obtained on application of tank mix combinations of topramezone 0.035 kg a.i/ ha+ atrazine 0.25 kg/ ha (at 20 DAS) and atrazine 0.75kg/ ha + pendimethalin 0.75 kg/ ha (pre-emergence application) in fodder maize (Jha *et al.*, 2022).

Experimental results of Bhimwal *et al.* (2019), reveals that tank mix combination of propaquizafop + imazethapyr (75+ 75 g/ ha) in soybean crop resulted in least weed density, weed dry matter, and highest weed control efficiency compared to sole application of the herbicides. This herbicide mixture also recorded highest yield, net returns and benefit cost ratio compared to individual applications.

In a field experiment by Lakshmidevi *et al.* (2022), at Anand Agricultural University, Gujarat , pre emergence application of tank mixed combination of pendimethalin + oxyfluorfen 900 + 120 g/ ha for weed control in ground nut resulted in pronounced increase in growth and yield attributes like plant dry weight, nodule dry weight, periodical plant height, number of pods per plant, pod yield, haulm yield, seed index, harvest index and shelling percentage , hence resulted in high net returns and benefit cost ratio.

2.1.2. Antagonistic effects

a) Studies in rice

Banga and Yadav (2004) noticed the poor weed control efficiency (32 %) of fenoxaprop when mixed with 2,4-D at 120+ 500 g/ ha and resulted in lower yield and yield attributes of rice while the combination of fenoxaprop with sulfosulfuron at 116+ 23.3 g/ ha gave promising yield and yield attributes with a weed control efficiency of 92 %.

Blouin *et al.* (2010) noticed that combination of bispyribac sodium, penoxsulam or imazethapyr with fenoxaprop reduced its weed control efficiency and resulted in decreased control of barnyard grass in rice, and the antagonistic effects increased over days after transplanting.

Antagonistic effects of mixtures of fenoxaprop-p-ethyl with imazethapyr+ imazapic, imazapyr + imazapic and bispyribac sodium with pronounced reduction in control of barnyard grass resistant to ALS inhibiting herbicides were reported by Matzenbacher *et al.* (2015). The antagonistic effect of imazapyr + imazapic in

combination with profoxydim in susceptible biotypes of barnyard grass was also reported by them.

Bhullar *et al.* (2016) revealed that tank mixture of fenoxaprop and azimsulfuron showed antagonistic effect and showed decline in control of *Leptochloa chinensis* in rice by 86 % in comparison with fenoxaprop when applied alone. Tank mixed application of fenoxaprop and azimsulfuron resulted in antagonistic effect which reduced efficacy in control of *Echinochloa colona* by 24 % and *Leptochloa chinensis* by 78 % in rice (Kumar *et al.*, 2018).

Atheena *et al.* (2017) found that combinations of cyhalofop butyl with pre-emergence herbicides of rice were less effective compared to their sequential application. The study confirmed that combination of cyhalofop butyl with Almix® resulted in less control of *Echinochloa stagnina* which confirms loss of activity of cyhalofop butyl.

Menon (2019) evaluated the performance of various herbicide mixtures in rice and reported that combination of fenoxaprop-p-ethyl and ethoxysulfuron caused reduced grain yields and less weed control efficiency (30 %).

b) Studies in other crops

Yadav *et al.* (2009) evaluated the compatibility of fenoxaprop-P-ethyl with various herbicides for tank mixed application and found out the resultant antagonistic activity when metsulfuron methyl, 2,4-D ester, and 2,4-D Na salt were combined separately with fenoxaprop-P-ethyl. The study also confirms synergistic effect of combination of fenoxaprop-P-ethyl with carfentrazone.

Yadav *et al.* (2009) identified that herbicide combinations of clodinafop/ fenoxaprop/ pinoxaden with sulfosulfuron/ mesosulfuron+ iodosulfuron resulted in more weed density and dry matter compared to their alone applications, hence these combinations were found less effective in controlling weeds of wheat.

2.2. TANK MIXED HERBICIDE-NUTRIENT COMBINATIONS

2.2.1. Additive/ Synergistic effects

a) Studies in rice

Combined application of urea and 2,4-D is recommended to increase the weed control efficiency of 2,4-D in rice (John and Sadanandan, 1989).

Pearson *et al.* (2008) evaluated the effect of urea ammonium nitrate (UAN) on herbicide efficiency of penoxsulam and revealed that UAN could improve the performance of herbicides in controlling barnyard grass in rice. Application of pretilachlor (@ 750 g/ ha) mixed with chemical fertilizers efficiently controlled weeds as well as decreased nutrient uptake by weeds in rice (Borah *et al.*, 2017).

According to Singh *et al.* (2016), tank mixing of urea @ 2 percent) with pre-mix herbicide penoxsulam + cyhalofop butyl was effective against *Ammania baccifera*, *Eclipta alba* and *Echinochloa* spp and resulted in highest grain and straw yield of rice. Reddy *et al.* (2021) also reported that tank mixing with urea enhanced the efficiency of herbicides bispyribac sodium and cyhalofop butyl + penoxsulam, (pre mix) compared to their application without urea.

a) Studies in other crops

In wheat, tank mix application of urea with clodinafop- propargyl was found effective in controlling weeds (Moeini *et al.*, 2006).

Carvalho *et al.* (2009) reported that glyphosate when mixed with urea and ammonium sulphate, enhanced the efficacy of glyphosate leading to accelerated weed desiccation.

Soliman *et al.* (2011), confirmed that (isoproturon+ diflufenca), tribenuron methyl and clodinafop propargyl when mixed with one percent urea resulted in significant increase in grain yield of wheat along with good weed control efficiency.

The results of a field experiment conducted by Tahir *et al.* (2011) in maize crop proved that addition of urea improved the phytotoxicity of herbicide foramsulfuron + isoxadifen + isosulfuron- methyl sodium and there was considerable saving in quantity of herbicides used.

2.2.2. Antagonistic effects

Field experiments conducted in glyphosate resistant soybean by Bailey *et al.* (2002) to evaluate effects of tank mixture applications of trimethyl sulfonium salts of glyphosate and isopropylamine with manganese formulations which (Mn lignin and Mn chelate) showed that weed control efficiency of herbicides were reduced by the addition of manganese especially for the control of lambsquarters.

Experimental results of Bernads *et al.* (2005) revealed that Manganese lignin sulfonate and Manganese sulfate reduced glyphosate efficiency, absorption and translocation when tank mixed with it.

2.3. TANK MIXING OF HERBICIDES- CRITERIA AND COMPATIBILITY

Herbicides of same chemical family are more likely to exhibit synergism and exhibit lower frequency of antagonistic effects in various crops (Zhang *et al.*, 1995).

Mixing of foliar fertilizer with pesticide mixtures resulted in altered pH and EC, and leads to physical or chemical incompatibility between compounds (Andrade *et al.*, 2013).

According to Gazziero (2015), approximately 97% of agrochemical users in Brazil mix up pesticides and apply them concomitantly and synergistic effects of some combinations were observed by Li *et al.* (2019).

The order in which various chemicals are mixed in a spray tank is important to avoid precipitation of products (Manucheri, 2018).

Actual pH and desired pH of tank mixture is a determinant of efficacy and according to Whitford *et al.* (2018) adding pH adjusters can help to get desired pH range for good foliar absorption.

2.4. Miscellaneous studies

Norris *et al.* (2001) verified the effects of tank mixture combinations of glyphosate with post emergence herbicides. As per the results, antagonistic effects was noticed when glyphosate C (Cheminova) or glyphosate Z (Zeneca) tank mixed with chlorimuron or cloransulam + flumetsulam, and imazethapyr.

As per the findings of Schuster *et al.* (2008), translocation of nicosulfuron when applied alone was 9 % more compared to the combined application of nicosulfuron when mixed with mesotrione or mesotrione + atrazine.

Addition of urea to glyphosate enhanced its efficiency of weed control (Samai and Muhidin, 2021). The combination of glyphosate 1.44 kg/ ha with urea 10 kg effectively managed weed flora.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The research programme entitled “Compatibility of multi nutrient mix Sampoorna with herbicides for rice” was conducted in 2022-2023 at Agricultural Research Station, Mannuthy, Kerala Agricultural University.

3.1 General Details

a) Location

The experiment was conducted at Agricultural Research Station, Mannuthy, Thrissur of Kerala Agricultural University. The station is situated at 10° 31' N latitude, 76° 13' E longitude and at an altitude of 40.29 m above mean sea level. The station is located 6 km away from Thrissur on southern side of Thrissur-Palakkad National Highway.

b) Soil

The soil of the experimental site was sandy clay loam, belonging to the taxonomical order oxisol. The soil was acidic in reaction with average pH of 6.4. The physico-chemical properties of the research area and the methods adopted are given in Table 1.

c) Climate and weather conditions

The experimental field is subjected to humid tropical climate. The mean monthly data of important meteorological parameters recorded during the period of experiment are given in Fig.1.

d) Variety

Rice variety Uma (MO16) was raised for the experimental purpose. Uma is a medium, bold seeded variety released from Rice Research Station, Moncompu, KAU. This medium duration variety (115-120 days) is medium tillering, non-lodging and resistant to brown plant hopper and gall midge. It is suited to all the

cropping seasons and it shows a dormancy period up to 3 weeks. Hence the variety is widely accepted and cultivated in majority of rice areas in Kerala.

e) Season

The crop period was from 12/07/2022 to 17/11/2022.

Table 1. Physico- chemical properties of soil of the experimental field

Sl. No	Particulars	Value	Method adopted
1	pH	6.4	1:2.5 soil: water suspension-pH meter (Jackson,1958)
2	EC (dS/m)	0.19	1:2.5 soil: water suspension-EC meter (Jackson,1958)
3	Organic carbon (%)	1.6	Walkley and Black method (Jackson, 1958)
4	Available N (kg/ha)	560	Alkaline permanganate method (Subbiah and Asija, 1956)
5	Available P ₂ O ₅ (kg/ha)	42	Bray-1 extractant – ascorbic acid reductant method (Olsen, 1965)
6	Available K ₂ O(kg/ha)	238	Neutral Normal NH ₄ OAC and estimation using flame photometry
7	Available Fe (mg/kg) Available Mn (mg/kg) Available Cu (mg/kg) Available Zn (mg/kg)	140 210 4.55 8.6	Extraction with 0.1 M HCl and estimation using Atomic Absorption Spectrophotometer (AAS)
8	Available B (mg/kg)	0.30	Azomethine-H method (Berger and Truog, 1939)
9	Available Mo (mg/kg)	-	Determination through ICP-AES

3.2 Experimental details

The experiment was conducted at Agricultural Research Station, Mannuthy. The experiment was laid out in Randomised Block Design with 13 treatments which were replicated thrice (Figure.2). Plot size was 5m x 4m. Sole application as well as tank mixed application of herbicides with Sampoorna was carried out at 20 days after transplanting. Follow up spray of Sampoorna was carried out at 40 DAT. The micronutrient composition in Sampoorna KAU multimix is provided in Table 2.

Table 2. Micronutrient content in the Sampoorna KAU multimix (rice)

Micronutrient	Nutrient content (%)
Zinc	4.0-6.5
Copper	0.3-0.5
Boron	3.5-4.5
Molybdenum	<0.02
Iron	<0.2
Manganese	<0.2

a) Land preparation and sowing

Field operations like ploughing, puddling and levelling were carried out. Seedlings were raised in a wet nursery and transplantation was done on 20th day after sowing in nursery at a spacing of 20 cm x 10 cm.

b) Fertilizer application

Urea, factomfos, and muriate of potash were utilised and fertilizer application was carried out with N, P₂O₅, and K₂O at 90:45:45 kg/ha (KAU, 2016). Half the recommended rate of nitrogen and potassium were applied basally along with full dose of phosphorus and the rest of the nutrients were applied at panicle initiation stage.

c) Plant protection measures

The experimental field was monitored for pest infestation and disease incidence. In the initial stage, yellowing of leaves was identified. *Pseudomonas fluorescens* was applied at 10g/ L of water and chlorantraniliprole (4kg/acre) was mixed with coir pith compost and broadcasted. Leaf rollers and gundhi bugs were prominent in the later stages which were controlled by chlorantraniliprole (3ml/ 10L) and malathion (2ml/ L) respectively.

d) Phytotoxicity scoring

Visual symptoms of phytotoxicity on crops were recorded on 3rd and 7th day after chemical application and injury symptoms were scored on a toxicity scale from 0 to 5 as described by Thomas and Abraham (2007).

Table 3. Dosages and time of application of post emergence herbicides, hand weeding and Sampoorna

No	Treatments	Time of application (DAT)
T ₁	Bispyribac sodium @ 0.03kg/ ha + Sampoorna	15-20
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15kg/ ha + Sampoorna	15-20
T ₃	2,4-D Na salt @ 0.8kg/ ha + Sampoorna	15-20
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha +Sampoorna	15-20
T ₅	Cyhalofop butyl @ 0.08kg/ ha + Sampoorna	15-20
T ₆	Bispyribac sodium @ 0.03kg/ ha	15-20
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15kg/ ha	15-20
T ₈	2,4-D Na salt @ 0.8 kg/ ha	15-20
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	15-20
T ₁₀	Cyhalofop butyl @ 0.08kg/ ha	15-20
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	20& 40
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	20& 40
T ₁₃	Un weeded Control (no Sampoorna)	-

Table 4. Herbicides, their commercial formulation and dosage used

No	Herbicides	Trade name and formulation
1	Bispyribac sodium	Nominee gold 10 SC
2	Cyhalofop butyl+ Penoxsulam	Vivaya 6.02 OD
3	2,4-D Na salt	Salix 95 SP
4	Metsulfuron methyl + Chlorimuron ethyl (premix)	Almix 20 WP
5	Cyhalofop butyl	Clincher 10 EC

Rating of phytotoxicity symptoms on crop

Rating	Effects on weeds	Effects on crop
0	None	No injury
1	Slight	Slight injury
2	Moderate	Moderate injury
3	Good control	Severe injury
4	Very good control	Very severe injury
5	Complete control	Complete destruction

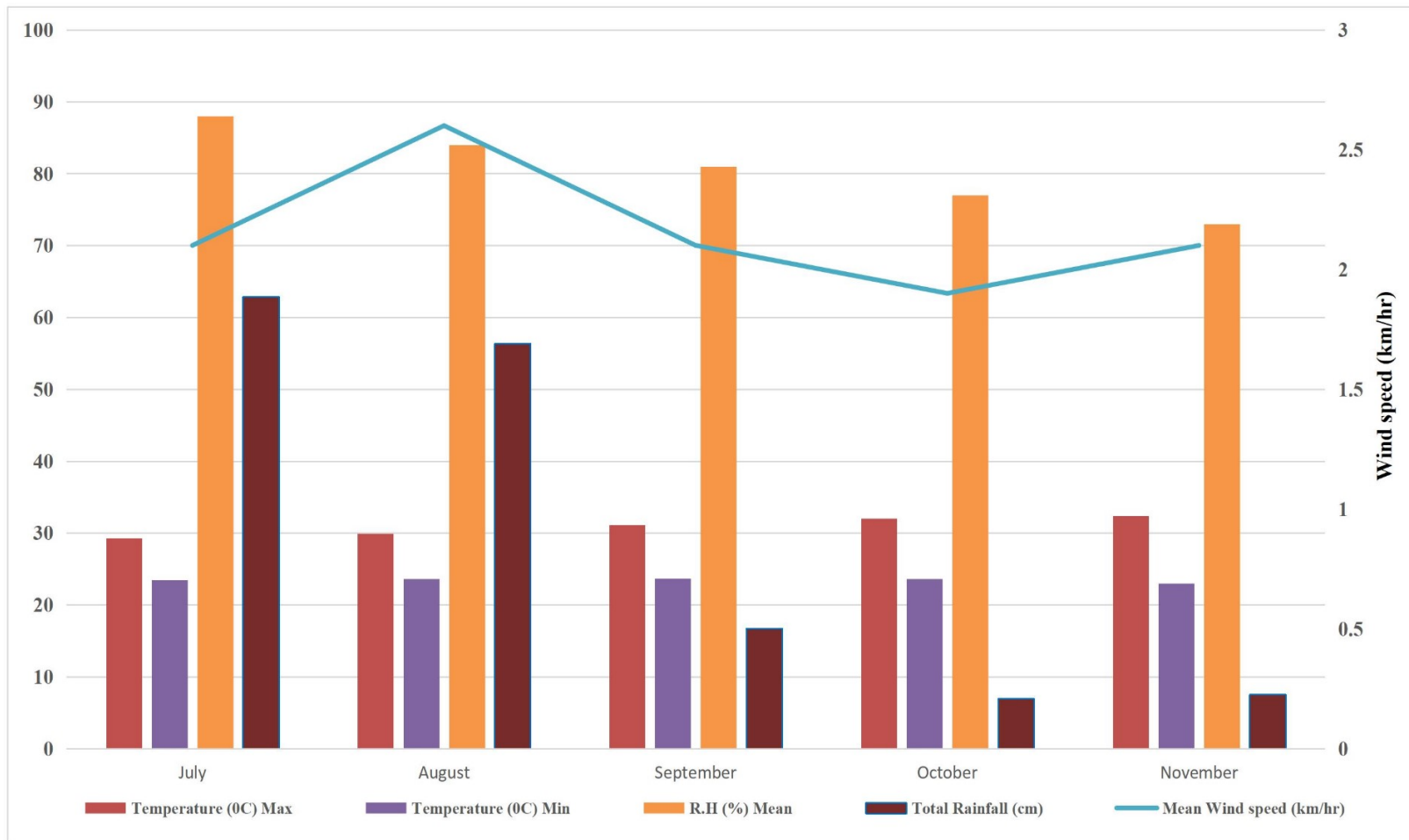


Fig.1. Weather data during the experimental period

3.4 Observations recorded

a) Plant height

Plant height (in cm) was measured at 30 days after transplanting (DAT) 60 DAT and at harvest. Height was measured from ground level to the tip of the longest leaf. At harvest, plant height was measured from the base of the crop to the tip of the panicle. Height (in cm) of five representative plants were recorded from each plot and the mean value was calculated.

b) Number of tillers per hill

The number of tillers per hill was counted at 30 and 60 DAT and at harvest. Observation was taken from 5 representative plants from each experimental plot and the average value was calculated.

c) Number of panicles per hill

The number of panicles per hill were recorded from ten hills from each treatment plot.

d) Number of grains per panicle

Healthy panicles were collected. Total number of grains present in each panicle were counted and the average was calculated.

e) Number of filled and unfilled grains per panicle

Grains from collected panicles each experimental plot were separated and number of filled grains and unfilled grains were counted.

f) Thousand grain weight

Dry weight of thousand grains collected from each plot were recorded. Average was calculated and expressed in grams.

g) Grain yield

Each experimental plot was harvested separately, followed by threshing, cleaning and drying. Dry weights of grain samples were recorded and expressed in kg/ ha.

h) Straw yield

The straw harvested from each plot were sun dried and dry weight was recorded. Yield was expressed in kg/ ha.

i) Harvest index

The harvest index was calculated using the formula:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Straw yield} + \text{grain yield}} \times 100$$

B. Observations on weed**a) Weed count**

Count of grasses, sedges and broad leaf weeds at 15, 45 and 60 days after spraying were recorded using a quadrat of size 0.25 m². Quadrats were placed randomly in respective treatment plots and all the weeds inside the area of quadrat were uprooted. Samples were collected at 15, 30 and 45 days after application of herbicides and the count was recorded as numbers/m².

b) Dry matter production of weeds

The weeds uprooted for taking weed count as mentioned above were cleaned and air dried for 2 days. They were oven dried to constant weight. Dryweights of weeds were recorded and expressed in kg/ha.

C. Plant analysis

Micronutrient content in leaves at panicle initiation stage of the crop, and N, P, and K content at harvest were estimated. Index leaves were collected from respective plots at crop PI stage for micro nutrient estimation. Plant samples were collected from individual plots at harvest stage in order to estimate N, P, and K uptake of crop. Nutrient content was estimated using following methods (Table 5):

Table 5. Methods adopted for plant analysis

Sl. No	Nutrient	Method adopted
1	N	Jeldhal digestion and distillation method (Jackson,1958)
2	P	Vanadomolybdate method by colorimetry (Jackson, 1958)
3	K	Flame photometer (Jackson,1958)
4	Fe, Mn, Cu, Zn	Diacid digestion followed by estimation using Atomic Absorption Spectrophotometer (AAS)
5	B	Azomethine-H method (Gaines and Mitchell, 1979) and Wolf (1971)
6	Mo	Determination through ICP-AES

Chlorophyll content

Chlorophyll content at panicle initiation stage and harvest stage was recorded by dimethyl sulphoxide (DMSO) extraction method (Hiscox and Israeistam, 1979). The intensity of colour was measured after 24 hours using spectrophotometer at 663 and 645 nm. Chlorophyll content was estimated and expressed in mg/ kg fresh weight.

$$\text{Chlorophyll a} = \frac{[(12.7 \times A_{663}) - (2.69 \times A_{645})] \times V}{1000 \times W}$$

$$\text{Chlorophyll b} = \frac{[(22.9 \times A_{645}) - (4.68 \times A_{663})] \times V}{1000 \times W}$$

$$\text{Total chlorophyll} = \frac{[(8.02 \times A_{663}) + (2.02 \times A_{645})] \times V}{1000 \times W}$$

Where;

A= Absorbance at specific wave length (nm)

V= volume of extract (ml)

W= fresh weight of plant sample (g)

D. Soil analysis

Soil samples were collected from experimental field randomly from different spots and they were mixed. Representative soil samples were collected from each experimental plots separately for post experimental analysis. Collected samples were air dried. The soil was sieved by 0.5 mm sieve and then transferred to polybags.

a) pH

pH readings were taken with the help of a pH meter. The soil was mixed with water in a ratio of 1:2.5 and shaken well. The electrode of the pH meter was dipped in the soil water suspension and the readings were recorded.

b) EC

The soil water suspension used for pH estimation was used for estimating soil EC values. EC meter electrode was dipped in the soil water suspension and reading was recorded in dS/ m.

c) Organic carbon

Organic carbon percentage in the soil sample was estimated using wet oxidation method (Walkley and Black, 1934).

d) Available nutrients

Soil analysis was carried out for available nutrients like N, P, K, Fe, Mn, Cu, Mo, Zn and B in the soil using standard procedures as described in Table 1.

E. Computed parameters

a) Nutrient Use Efficiency (NUE)

Nutrient use efficiency was calculated and expressed in percentage by following formula:

$$\text{NUE (\%)} = \frac{\text{Grain yield (kg/ha)}}{\text{Nutrient applied (kg/ha)}} \times 100$$

b) Weed Control Efficiency (WCE)

Weed control efficiency (percentage) for each treatment was calculated by the formula:

$$\text{WCE (\%)} = \frac{\text{WDMP in unweeded control} - \text{WDMP in treatment}}{\text{WDMP in unweeded plot}} \times 100$$

* WDMP = Weed Dry Matter Production

c) Weed Index (WI)

Weed index percentage for each treatment was calculated by using the formula:

$$\text{WI} = \frac{\text{Grain yield in hand weeded plot} - \text{Grain yield in treatment}}{\text{Grain yield in hand weeded plot}} \times 100$$

d) Benefit cost ratio

The ratio of gross returns from cultivation and gross cost of cultivation was calculated. Gross cost of cultivation includes economical returns from straw and grain. The gross cost of cultivation includes different costs expended for field operations like land preparation, cost of inputs, labour charges etc.

Data analysis

All the observed and computed values were statistically analysed using “GRAPES” statistical software (Gopinath *et al.*, 2020).

4. RESULTS

A field experiment entitled “Compatibility of multinutrient mix Sampoorna with herbicides for rice” was conducted during 2022-2023 at Agricultural Research Station, Mannuthy in order to explore the scope of tank mixing KAU Sampoorna multimix with few post emergence herbicides recommended for rice. The crop was transplanted 20 days after sowing in a nursery and herbicides were sprayed 20 days after transplanting. The findings are furnished below.

4.1. Phytotoxicity to rice

The crop was examined for visual symptoms of toxicity after spraying and scoring was done at third and seventh day after spraying (Table 7) based on phytotoxicity score of 0-5 as provided by Thomas and Abraham (2007). Of the various sprays, only the tank mixed combination of 2,4-D with Sampoorna resulted in phytotoxicity to rice. The phytotoxicity score was 4, indicating severe phytotoxicity by 3rd day after spraying. By 7th day, a lower score of 3 was recorded, and later the crop revived as the new leaves formed did not exhibit any phytotoxicity.

4.2. Plant height

Plant height was recorded at three different stages, 30 and 60 days after transplanting (DAT) and at harvest. The data are furnished in Table 8. Average plant height was 55.8 cm at 30 DAT. The tallest plants were observed in bispyribac sodium+ Sampoorna (T₁) (59.17 cm) which was superior to sole application of bispyribac sodium, which recorded a plant height of 56.5 cm. Significant reduction in plant height was observed while Sampoorna was tank mixed with 2,4-D resulting in a plant height of 46.57 cm compared to a height of 56.33 cm in case of application of 2,4-D. Similar trend was shown when metsulfuron methyl + chlorimuron ethyl was applied with Sampoorna (47.93 cm). All other treatments showed statistically comparable plant height.

Almost a similar trend in plant height was observed at 60 DAT also. Average plant height was 87.3cm. Individual applications and Sampoorna tank mixed applications of herbicides showed comparable heights except in the case of 2,4-D and metsulfuron methyl + chlorimuron ethyl. Sampoorna tank mixed with 2,4-D continued to register significantly lower height (74.6 cm) compared to its sole application. Similar trend was observed in metsulfuron methyl + chlorimuron ethyl with a significantly lower height of 79 cm when Sampoorna was tank mixed with it.

Taller plants were observed in Sampoorna tank mixed with cyhalofop butyl (T₅) or bispyribac sodium (T₁) compared to their individual applications (T₁₀ and T₆ respectively), at harvest. Also, hand weeding+ Sampoorna (T₁₂) showed significantly higher plant height of 120 cm compared to that in hand weeding without Sampoorna (T₁₁) with 114 cm. Tank mixing Sampoorna with cyhalofop butyl+ penoxsulam resulted in a plant height of 119.33 cm comparable to the individual application of the herbicide (119.67 cm). Similar trend was shown by metsulfuron methyl + chlorimuron ethyl, where plant heights in sole and Sampoorna tank mixed applications were 114 cm and 112 cm respectively. Unweeded control(T₁₃) and 2,4-D Na+ Sampoorna (T₃) registered lower plant height, which were statistically comparable.

4.3. Number of tillers per hill

There was no significant difference in tiller number between treatments at 30 DAT (Table 9). Average tiller number at this stage was 10 no.s/ hill.

An average tiller number of 15 was registered at 60 DAT. The highest tiller number was exhibited by cyhalofop butyl+ penoxsulam (premix)+ Sampoorna (T₂), with an average value of 22, while the lowest value of 9 was registered with the treatment 2,4-D+ Sampoorna (T₃). Unweeded control resulted in a comparable tiller count of 11 to that registered in 2,4-D+ Sampoorna. Individual application of herbicides resulted in comparable values with respect to their Sampoorna- tank mixed applications except in the case of 2,4-D and metsulfuron

methyl + chlorimuron ethyl. The latter registered significantly lower tiller count on tank mixing with Sampoorna compared to sole application. Hand weeding with and without Sampoorna, showed statistically comparable values for tiller numbers which were 19.33 and 19 respectively.

Average tiller number at harvest stage was 21. Treatments T₂, T₅, T₁, T₇, and T₁₂ registered higher as well as comparable tiller numbers of 26, 25, 24, 24, and 23 respectively. Hand weeding with or without Sampoorna spray resulted in comparable tiller counts (22 and 23 respectively). Sole application of bispyribac sodium, cyhalofop butyl and metsulfuron methyl + chlorimuron ethyl registered statistically comparable tiller number which were comparable to that in hand weeding (T₁₁). Spraying metsulfuron methyl + chlorimuron ethyl or 2,4-D alone registered tiller numbers of 20 and 19 respectively, and their tank mixed combinations with Sampoorna registered still lower number of tillers (17 and 15 respectively). Comparing sole application and tank mixed application of herbicides, all the treatments except 2,4-D resulted in number of tillers statistically on par with that registered in their tank mixed application with Sampoorna. 2,4-D registered tiller number of 15 when tank mixed with Sampoorna which was significantly lesser than that in its sole application (19). Tank mixed applications of metsulfuron methyl + chlorimuron ethyl and 2,4-D alone or with Sampoorna resulted in comparable and lower number of tillers at harvest. Significantly lower number of tillers was registered in unweeded control plot.

4.4. Yield parameters

Number of productive tillers

Productive tillers per hill varied due to different treatments and the values ranged from 20 no./hill in cyhalofop+ Sampoorna to as low as 10 in unweeded control (Table 9). Compared to other treatments involving herbicides, lower number of productive tillers was registered in the case of 2,4-D and metsulfuron methyl + chlorimuron ethyl when tank mixed with Sampoorna which were

comparable with each other. Productive tiller number of 20 was registered in metsulfuron methyl + chlorimuron ethyl while its tank mix application with Sampoorna resulted in 15 productive tillers which were significantly different. Similarly, when 2,4-D was tank mixed with Sampoorna, productive tillers of 13 compared to significantly higher number of 17 in its sole application was registered. Two hand weeded treatments showed statistically on par results. This was in turn comparable with many other treatments (with or without Sampoorna) and the values ranged from 19 to 20 productive tillers per hill. Unweeded control registered 10 productive tillers which was significantly lower than all other treatments.

Grains per panicle and test weight

Number of grains per panicle varied from 104 no.s in unweeded control to 191 no.s in cyhalofop butyl+ penoxsulam (Table 10). All the treatments except unweeded control registered comparable number of grains per panicle. An average of 166 grains per panicle was registered in all other treatments except unweeded control at harvest. The data are furnished in Table 8.

The number of filled and unfilled grains per panicle showed a similar pattern to the number of total grains. Number of filled grains varied from 85 no.s per panicle in unweeded control to 166 no.s per panicle in cyhalofop butyl+ penoxsulam+ Sampoorna. Number of unfilled grains per panicle ranges from 20 no.s in unweeded control to 29 no.s in tank mixed combinations of cyhalofop butyl+ penoxsulam or cyhalofop butyl with Sampoorna. All the treatments except unweeded control registered statistically comparable values for total, filled and unfilled number of grains per panicle, while unweeded control registered the lowest value for all the above-mentioned yield attributes.

The test weight values ranged from 24 g to 25 g and there was no significant variation among the treatments with respect to test weight of seeds.

4.5. Grain and straw yield

Grain yield

Grain yield in various treatments varied significantly and in general, most of the tank mix sprays gave comparable yield to the application of herbicides alone (Table 11). The lowest grain yield was recorded in unweeded control (T₁₃) with 1437 kg/ ha. All the herbicides except 2,4-D and metsulfuron methyl + chlorimuron ethyl registered grain yield statistically comparable to respective sole application and with that of hand weeded plots. Tank mixed combinations of 2,4-D or metsulfuron methyl + chlorimuron ethyl with Sampoorna registered significantly lower grain yield (4499 kg/ ha and 4917 kg/ ha respectively) compared to that registered in their sole applications (5318 kg/ ha and 5370 kg/ ha respectively).

Straw yield

Straw yield registered in different treatments resembled the trend of grain yield (Table 11). Straw yield ranged from 1753 kg/ ha in unweeded control to 6724 kg/ ha in cyhalofop butyl+ penoxsulam tank mixed with Sampoorna (T₂). Straw yield in hand weeded plots were comparable to each other, which were statistically on par to all other treatments except tank mixed applications of 2,4-D or metsulfuron methyl + chlorimuron ethyl with Sampoorna and unweeded control. A straw yield of 6066 kg/ ha was registered in 2,4-D while its tank mixed application with Sampoorna registered significantly lower straw yield of 5101 kg/ ha. Rest of the herbicides and their respective tank mixed combinations registered straw yield statistically on par with each other. The inferior treatments 2,4-D+ Sampoorna and unweeded control differed statistically from each other with a straw yield of 5101 kg/ ha and 1753 kg/ ha respectively.

Harvest Index (HI)

No significant variation was recorded in harvest index values registered in treatments (Table 11). All the treatments registered harvest index values which were in a narrow range from 0.46 to 0.48.

4.6. Chlorophyll content

Chlorophyll a, chlorophyll b and total chlorophyll content varied significantly among different treatments at PI stage and data are furnished in Table 12. All the herbicides except 2,4-D registered higher but comparable chlorophyll a content on tank mixing with Sampoorna. Hand weeding with Sampoorna registered significantly higher chlorophyll a content compared to hand weeded plot without Sampoorna application. Significantly lower chlorophyll a content of 2.19 mg/g fresh weight was registered in tank mix application of 2,4-D with Sampoorna compared to sole application of the herbicide. Unweeded control registered chlorophyll a content of 2.20 mg/g fresh weight which was statistically on par with that registered in hand weeded plot without Sampoorna application.

Similar trend was followed in chlorophyll b content at PI stage. All the herbicides except 2,4-D registered higher but comparable chlorophyll b content in tank mixed combination with Sampoorna. 2,4-D registered chlorophyll b content of 0.75 mg/g with tank mix application with Sampoorna while, its sole application registered chlorophyll b content of 1.13 mg/g fresh weight. Unweeded control registered comparable chlorophyll b content with that registered in tank mix application of 2,4-D with Sampoorna.

Total chlorophyll content at PI stage differed among treatments. Bispyribac sodium registered significantly lower chlorophyll content of 3.29 mg/g compared to chlorophyll content in tank mix application with Sampoorna (3.61 mg/g). Hand weeding plot registered chlorophyll content of 3.40 mg/g while hand weeding along with Sampoorna registered significantly higher chlorophyll content of 3.80 mg/g.

Chlorophyll a content at heading stage varied significantly among different treatments (Table 13). Bispyribac sodium registered significantly higher chlorophyll a content (2.44 mg/g) on tank mix application with Sampoorna compared to sole application with 2.27 mg/g chlorophyll a content. All other herbicides except 2,4-D registered comparable chlorophyll a content on tank

mixed application with Sampoorna and respective sole applications. Hand weeding+ Sampoorna registered significantly higher chlorophyll a content (2.53 mg/g) in comparison with hand weeding plot without Sampoorna application (2.33 mg/g). Unweeded control plot registered statistically comparable chlorophyll a content to hand weeding (without Sampoorna) as well as tank mixed 2,4-D with Sampoorna application.

Chlorophyll b content and total chlorophyll content at heading stage followed similar trend in all the treatments involving herbicides. Hand weeded plots registered chlorophyll b content which were on par with each other. Comparing hand weeded plots, total plant chlorophyll content registered in hand weeding+ Sampoorna was significantly higher than hand weeded plot without Sampoorna application. Unweeded control registered chlorophyll b content and total chlorophyll statistically on par to tank mix application of 2,4-D with Sampoorna.

4.7. Weed count

Count of grasses, sedges and broad leaf weeds differed in all treatments at 30 and 60 days after transplanting (DAT) and at harvest. A significantly higher count of grasses (24 no.s / m²), sedges (16 no.s / m²) and broad leaf weeds (43 no.s / m²) were registered in unweeded control which proved to be inferior among all the treatments. Density of sedge species was very low in experimental plot at all the stages of observation.

A comparable weed count for grasses and sedges was registered at 30 DAT in all other treatments (hand weeding was done in treatments involving narrow spectrum herbicides like cyhalofop butyl, 2,4-D and metsulfuron methyl + chlorimuron ethyl, to remove non-targeted grass weeds) (Table 13). The highest count for broad leaf weeds at this stage was registered in unweeded control followed by statistically comparable values in most of the treatments. Among the treatments involving herbicides, 2,4-D and bispyribac sodium tank mixed with Sampoorna registered lower number of broad leaf weeds. This was followed by

comparable but lower weed counts in hand weeded plots. Analysing the total weed count registered in different treatments, unweeded control plot registered the highest number of weeds. All the treatments including herbicides registered comparable weed count, while hand weeded plots registered significantly lower number of weeds compared to all other treatments.

Grass species registered comparable weed density at 60 DAT, within all the herbicidal treatments (Table 15). Hand weeded plots registered lower but comparable number of grasses. Unweeded control was the inferior treatment with the highest number of grass population to the tune of 26 no.s/ m². Number of sedges registered in most of the treatments were statistically on par with each other, while tank mix application of 2,4-D tank mixed with Sampoorna registered significantly lower weed count than that of sole application of 2,4-D. Unweeded control plot registered the highest number for sedge weeds with 8 no.s/ m². All the herbicides except cyhalofop butyl and cyhalofop butyl+ penoxsulam registered comparable density for broad leaf weeds with respect to their tank mix application with Sampoorna, while the above- mentioned treatments registered significantly reduced number of broad leaf weeds on tank mix application with Sampoorna. Unweeded control registered the highest broad leaf weed count (75 no.s /m²). Hand weeded plots registered comparable weed count for broad leaf species.

The highest number of grass weeds was registered in unweeded control at harvest (Table 16). Most of the treatments registered statistically comparable weed count for grass species. Hand weeded plots registered lower number of grasses. The number of sedges were not affected by different treatments at harvest. The highest number of broad leaf weeds was registered in unweeded control while the lowest weed density was registered in hand weeded plot. All the treatments involving herbicides except cyhalofop butyl and 2,4-D registered comparable weed count. Cyhalofop butyl (32 no.s/ m²) registered significantly lower number of broad leaf weeds on tank mix application with Sampoorna, while 2,4- D registered significant increase in number of broad leaf weeds on tank mix

application with Sampoorna. Hand weeding along with Sampoorna application registered significantly higher broad leaf weed count in comparison with hand weeding. All the treatments involving herbicides registered statistically comparable total weed count, while hand weeded plots registered weed count statistically comparable with each other but significantly lower than that registered in all other treatments. Unweeded control was the inferior treatments which registered total weed count of 83 no.s/ m² which was the highest among the treatments.

4.8. Weed dry matter production

At 30 DAT, most of the treatments registered statistically comparable weed dry matter production (Table 17). The weed dry matter production in hand weeded plots were statistically on par with each other and with that registered in cyhalofop butyl+ penoxsulam. Dry matter production registered in cyhalofop butyl+ penoxsulam was statistically on par to the values registered in all other treatments involving herbicides. Sole applications of herbicides and their respective tank mix applications with Sampoorna registered statistically comparable weed dry matter accumulation. All the treatments involving herbicides as well as hand weeded plots registered weed dry matter production statistically superior to unweeded control. Unweeded control registered the highest weed dry matter accumulation of 551 kg/ ha.

By 60 DAT, weed dry matter accumulation in unweeded plot doubled to 1240 kg/ ha. All the treatments involving herbicides as well as hand weeding plots were statistically on par in terms of weed dry matter registered. Sole application as well as tank mixed applications of respective herbicides were equally efficient in terms of weed management as they registered comparable weed dry weight.

At harvest, all treatments except unweeded control registered comparable weed dry matter accumulation and the values ranged from 150 kg/ ha in bispyribac sodium to 203 kg/ ha in tank mixed application of cyhalofop butyl+

penoxsulam with Sampoorna. Unweeded control was inferior to all other treatments with weed dry matter accumulation of 1373 kg/ ha.

4.10. Plant analysis

Micronutrient content at panicle initiation (PI) stage of the crop

Analysing micro nutrient content at Panicle Initiation stage (PI stage) (Table 18), Fe content was not significantly affected by various treatments of the experiment. An average value of 918 mg/ kg was reported after the soil analysis of soil samples from experimental field.

An average Mn content of 1340.63 mg/ kg is present in the crop at plant PI stage. Among all the treatments, cyhalofop butyl resulted in the lowest Mn content of 887 mg per kg dry weight while mixed with Sampoorna which was statistically on par with the sole application of cyhalofop butyl with a manganese content of 1046 mg/ kg of dry weight. Hand weeding along with Sampoorna application was the best treatment with the highest 1879.58 mg/ kg Mn content at PI stage, which is closer to the Mn content exhibited in the treatments like metsulfuron methyl+ chlorimuron methyl, 2,4-D+ Sampoorna, 2,4-D *etc.* The Mn content in 2,4-D was followed by that of hand weeding without Sampoorna which was comparable with the rest of the treatments. All the herbicides exhibited comparable Mn content with their respective tank mixed combinations, while significantly higher Mn content was exhibited by hand weeding with Sampoorna than without Sampoorna.

The copper content at plant PI stage was not significantly affected by the treatments and it ranges from 9.25 mg/ kg in 2,4-D to 6.917 mg/ kg in tank mixed application of cyhalofop butyl+ penoxsulam with Sampoorna.

Mo content at PI stage of the crop ranged from 2393.33 in cyhalofop + Sampoorna to 3121.66 mg/ kg in cyhalofop butyl application and it was not significantly affected by the treatments. An average Zn content of 42.9 mg/ kg was registered at plant PI stage. The highest Zn content of 58.91 mg/ kg was reported in tank mixed application of metsulfuron methyl + chlorimuron ethyl

with Sampoorna followed by 57.50 mg/ kg in hand weeding + Sampoorna. Bispyribac sodium registered next highest Zn content after T₁₁, while it is also comparable to that of all other chemical and non-chemical treatments. Boron content at PI stage exhibited a normal value of 21.29 mg/ kg and the boron content was not significantly affected by the treatments.

Nutrient uptake at harvest

An average nitrogen uptake of 199.6 kg/ ha was registered at harvest (Table 19). Among all the treatments, higher nitrogen uptake at harvest was reported in hand weeding+ Sampoorna with n uptake of 220 kg/ ha which was statistically comparable with most of the treatments. Among tank mixed combinations of herbicides and Sampoorna, 2,4-D registered the lowest N uptake of 157 kg/ ha with Sampoorna. This was followed by N uptake registered in tank mix application of metsulfuron methyl + chlorimuron ethyl with Sampoorna (181 kg/ ha).

Phosphorus uptake values ranges from 15 kg/ ha in unweeded control plot to 67 kg/ ha in hand weeded plot. All other treatments except unweeded control registered comparable P uptake values. The lowest P uptake was registered in unweeded control which was inferior to all other treatment applications. Comparing all the tank mixed combinations with hand weeded plot with Sampoorna application, 2,4-D or metsulfuron methyl + chlorimuron ethyl registered significantly lower P uptake in combination with Sampoorna.

K uptake at harvest registered comparable values in most of the treatments. 2,4-D registered lower K uptake of 194 kg/ ha in comparison with all other herbicides and tank mixed application of the same with Sampoorna registered the lowest uptake of 165 kg/ ha. The lowest K uptake in 2,4-D+ Sampoorna was followed by tank mix application of metsulfuron methyl + chlorimuron ethyl with Sampoorna (191 kg/ ha). Unweeded control was the inferior treatment with K uptake of 59 kg/ ha.

4.11. Soil Analysis

pH

An average soil pH of 6.48 was reported from the experimental field after the experiment (Table. 20). Higher pH value of 6.56 was reported in bispyribac sodium and lower pH of 6.44 was recorded in cyhalofop butyl+ penoxsulam (premix) + Sampoorna (T₂). Soil pH was not affected significantly by the treatment applications.

Electrical Conductivity (EC)

Soil EC value ranged from 0.19 dS/m in the experimental plot with bispyribac sodium application to a value of 0.22 dS/m in few treatments (Table. 20). Soil EC was not significantly affected by the treatment applications.

Organic carbon

Organic carbon content did not vary significantly among different treatments. An average value of percentage was recorded in the experimental field after the experiment (Table. 20). It differed from 1.56 % in tank ix application of cyhalofop butyl+ penoxsulam with Sampoorna to 1.74 % in cyhalofop butyl.

Available N P K

Available nitrogen of 529 kg/ ha was registered in experimental plot (Table. 20). Available nitrogen did not differ significantly among different treatments. Available phosphorus in soil ranged from 32 kg/ ha to 37 kg /ha in different treatments. No significant variation was registered for available phosphorus in different treatments. Available potassium content in soil averaged 239 kg/ ha and did not differ significantly among treatments.

Available micronutrients

Available micronutrients like Fe, Mn, Cu, Mo, Zn and B, registered average values of 145.9 mg, 215.5 mg, 4.74 mg, 0 mg, 8.87 mg and 0.304 mg per kg of soil respectively and the available micronutrients were not significantly affected

by the treatment applications (Table. 21). Available Fe content was ranged from 112.60 mg/ kg in cyhalofop butyl to 168.73 mg/ kg in hand weeding+ Sampoorna. Available Mn content ranged from 168.70 mg/ kg in 2,4-D+ Sampoorna to 260.90 mg/ kg in cyhalofop butyl+ penoxsulam (T₇). Higher available Cu (5.31 mg/ kg) was reported in cyhalofop butyl+ Sampoorna while lower Cu content was registered in tank mixed application of bispyribac sodium with Sampoorna (3.96 mg/ kg). Available Zn was in a range from 8.42 mg/ kg in T₁ to 9.76 mg/ kg in T₇. An average value of available boron content of 0.33 mg/ kg was reported from the experimental field with higher value recorded being 0.44 mg/ kg in cyhalofop butyl and the lowest value reported in bispyribac sodium+ Sampoorna (T₁), with 0.26 mg/ kg. Available micronutrients like Fe, Mn, Cu, Mo, Zn, and B were not significantly affected by the treatment applications.

Available molybdenum in all experimental plots were below the detectable level.

4.12. Weed Control Efficiency (WCE)

Weed control efficiency at 30 and 60 days after transplanting and at harvest differed among different treatments and data are furnished in Table 22. Hand weeding plots registered significantly higher weed control efficiencies with respect to other treatments which were statistically on par with each other. Most of the herbicides registered comparable weed control efficiencies in comparison with their respective tank mix combination with Sampoorna.

At 60 days after transplanting, all the treatments involving herbicides registered statistically comparable weed control efficiency. Hand weeded plots registered significantly higher weed control efficiency at 60 DAT in comparison with other treatments.

At harvest all the treatments except unweeded control registered comparable weed control efficiency.

4.13. Percentage reduction in yield

Percentage reduction in yield varied among different treatments and data are furnished in Table 22. Unweeded control was the inferior treatment with higher

yield reduction of 74 percentage. Among tank mixed combinations of post emergence herbicides with Sampoorna, 2,4-D + Sampoorna registered yield reduction of 21 % which was higher. This was followed by tank mixed metsulfuron methyl + chlorimuron ethyl with Sampoorna with a yield reduction of 13 %. 2,4-D registered yield reduction of 5.55 % and all other herbicides and their respective tank mixed combinations with Sampoorna registered lower reduction in yield.

4.14. B: C ratio

Among tank mixed combinations of herbicides with Sampoorna, 2,4-D registered the lowest B:C ratio of 1.92 followed by tank mixed metsulfuron methyl + chlorimuron ethyl with Sampoorna, with a B:C ratio of 2.05. All other tank mixed combinations registered B:C ratio above 2 (Table 23). Comparing all the treatments, unweeded control plot registered the lowest B:C ratio of 0.65, which was followed by hand weeded plots. B:C ratio of 1.77 and 1.80 was registered in hand weeded plots with and without Sampoorna respectively. Income from grain was the highest in hand weeded plots while it was the lowest in unweeded control (Rs. 40955/ ha) followed by tank mix application of 2,4-D with Sampoorna (Rs. 128231/ ha). Income from straw was higher in tank mixed application of Sampoorna with cyhalofop butyl+ penoxsulam (premix), while the lowest income was reported in unweeded control. Among tank mixed combinations, 2,4-D tank mixed with Sampoorna registered the lowest income from straw (Rs. 35709) which was followed by straw income in tank mixed metsulfuron methyl + chlorimuron ethyl with Sampoorna (Rs. 40950/ ha). Among different treatments, hand weeded plots registered higher cost. The lowest cost was registered in unweeded control. Among tank mixed combinations, tank mix application of 2,4-D with Sampoorna and metsulfuron methyl + chlorimuron ethyl with Sampoorna registered lower net returns (Rs. 78694/ ha and Rs. 92688/ ha respectively). Even though gross income was higher in hand weeded plots, the treatments registered lower net returns of Rs. 90309/ ha (Hand weeding+

Sampoorna), and Rs. 92104/ ha (Hand weeding, without Sampoorna application), as they registered higher costs of cultivation.

Table 7. Effect of herbicides tank mixed with Sampoorna on phytotoxicity scoring on rice

Treatments		Phytotoxicity score	
		3 DAA [†]	7 DAA
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	0	0
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	0	0
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	4	3
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	0	0
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	0	0
T ₆	Bispyribac sodium @ 0.03 kg/ ha	0	0
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	0	0
T ₈	2,4-D Na salt @ 0.8 kg/ ha	0	0
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	0	0
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	0	0
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	0	0
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	0	0
T ₁₃	Un weeded Control (no Sampoorna)	0	0

[†] Days after application

Table 8. Effect of herbicides tank mixed with Sampoorna on plant height of rice

Treatments		Plant height (cm)		
		30 DAT	60 DAT	Harvest
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	59.17 ^a	91.17 ^a	120.33 ^{ab}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	57.70 ^{bc}	90.93 ^a	119.33 ^{ab}
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	46.57 ^g	74.67 ^d	99.33 ^e
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	47.93 ^f	79.00 ^c	112.00 ^d
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	57.03 ^{cd}	90.17 ^a	122.67 ^a
T ₆	Bispyribac sodium @ 0.03 kg/ ha	56.50 ^{de}	90.50 ^a	114.67 ^{cd}
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	57.50 ^{bc}	89.50 ^a	119.67 ^{ab}
T ₈	2,4-D Na salt @ 0.8 kg/ ha	56.33 ^{de}	83.33 ^b	113.00 ^{cd}
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	55.67 ^e	84.67 ^b	114.00 ^{cd}
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	57.93 ^{bc}	89.83 ^a	116.67 ^{bc}
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	57.43 ^{bc}	90.77 ^a	120.00 ^{ab}
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	57.50 ^{bc}	90.67 ^a	114.00 ^{cd}
T ₁₃	Un weeded Control (no Sampoorna)	58.03 ^b	89.76 ^a	101.00 ^e

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 9. Effect of herbicides tank mixed with Sampoorna on number of tillers per hill of rice

Treatments		No. of tillers/hill		
		30 DAT	60 DAT	Harvest
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	10.67 ^{*NS}	16.67 ^{cde}	24.33 ^{ab}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	11.00	22.33 ^a	25.67 ^a
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	9.67	9.33 ^f	15.33 ^e
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	9.33	14.33 ^e	17.33 ^{de}
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	11.00	17.67 ^{bcd}	25.00 ^{ab}
T ₆	Bispyribac sodium @ 0.03 kg/ ha	11.33	16.67 ^{cde}	22.00 ^{bc}
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	10.67	18.67 ^{bc}	24.00 ^{ab}
T ₈	2,4-D Na salt @ 0.8 kg/ ha	10.00	15.67 ^{de}	18.66 ^d
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	10.33	17.00 ^{bcd}	20.00 ^{cd}
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	11.00	16.67 ^{cde}	22.00 ^{bc}
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	10.33	19.33 ^b	22.33 ^{bc}
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	11.00	19.00 ^{bc}	23.00 ^{abc}
T ₁₃	Un weeded Control (no Sampoorna)	10.33	10.67 ^f	11.00 ^f

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

*NS: Non Significant

Table 10. Effect of herbicides tank mixed with Sampoorna on yield attributes of rice

Treatments		Productive tillers (No./ hill)	Filled grains/panicle (No.)	Unfilled grains/panicle (No.)	Total grains/panicle (No.)	Test weight (g)
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	18.67 ^{ab}	165.28 ^a	28.38 ^a	179.00 ^a	24.47* ^{NS}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	20.00 ^a	165.93 ^a	29.06 ^a	185.66 ^a	24.22
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	13.00 ^d	162.71 ^a	28.28 ^a	180.66 ^a	24.40
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	15.33 ^{cd}	158.06 ^a	27.60 ^a	179.00 ^a	24.73
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	20.33 ^a	165.00 ^a	29.00 ^a	174.00 ^a	24.21
T ₆	Bispyribac sodium @ 0.03 kg/ ha	17.67 ^{abc}	152.95 ^a	28.05 ^a	179.00 ^a	24.18
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	18.67 ^{ab}	158.66 ^a	28.00 ^a	191.00 ^a	24.36
T ₈	2,4-D Na salt @ 0.8 kg/ ha	16.67 ^{bc}	160.10 ^a	26.56 ^a	177.66 ^a	24.27
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	19.66 ^a	160.80 ^a	27.20 ^a	176.66 ^a	24.40
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	19.33 ^a	161.78 ^a	28.55 ^a	178.33 ^a	24.15
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	19.66 ^a	159.23 ^a	28.10 ^a	172.66 ^a	24.50
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	20.00 ^a	162.35 ^a	28.65 ^a	184.00 ^a	24.11
T ₁₃	Un weeded Control (no Sampoorna)	10.00 ^e	84.70 ^b	19.63 ^b	104.33 ^b	24.24

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

*NS: Non Significant

Table 11. Effect of herbicides tank mixed with Sampoorna on grain yield, straw yield and harvest index of rice

Treatments		Grain yield (kg/ ha)	Straw yield (kg/ ha)	Harvest index
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	5444 ^{ab}	6335 ^{abc}	0.46
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	5647 ^{ab}	6724 ^a	0.46
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	4499 ^d	5101 ^d	0.47
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	4917 ^c	5850 ^c	0.46
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	5452 ^{ab}	6311 ^{abc}	0.46
T ₆	Bispyribac sodium @ 0.03 kg/ ha	5501 ^{ab}	6657 ^{ab}	0.45
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	5607 ^{ab}	6168 ^{abc}	0.48
T ₈	2,4-D Na salt @ 0.8 kg/ ha	5318 ^b	6066 ^{bc}	0.47
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	5370 ^{ab}	6252 ^{abc}	0.46
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	5660 ^{ab}	6398 ^{abc}	0.47
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	5722 ^a	6437 ^{abc}	0.47
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	5686 ^{ab}	6520 ^{ab}	0.46
T ₁₃	Un weeded Control (no Sampoorna)	1437 ^e	1753 ^e	0.46

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 12. Effect of tank mixed herbicides with Sampoorna on chlorophyll content in rice at panicle initiation stage

Treatments		Chlorophyll content mg g ⁻¹ of fresh weight		
		Chlorophyll a	Chlorophyll b	Total Chlorophyll
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	2.44 ^{ab}	1.17 ^{ab}	3.61 ^{ab}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	2.40 ^{abc}	1.15 ^{ab}	3.56 ^{abcd}
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	2.19 ^e	0.75 ^c	2.94 ^e
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	2.39 ^{abc}	1.02 ^b	3.42 ^{bcd}
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	2.37 ^{bc}	1.06 ^{ab}	3.44 ^{bcd}
T ₆	Bispyribac sodium @ 0.03 kg/ ha	2.27 ^{cd}	1.02 ^b	3.29 ^d
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	2.28 ^{bcd}	1.03 ^b	3.32 ^{cd}
T ₈	2,4-D Na salt @ 0.8 kg/ ha	2.29 ^{bcd}	1.13 ^{ab}	3.42 ^{bcd}
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	2.41 ^{abc}	1.19 ^{ab}	3.60 ^{abc}
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	2.36 ^{bc}	1.11 ^{ab}	3.48 ^{bcd}
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	2.53 ^a	1.26 ^a	3.80 ^a
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	2.33 ^{bcd}	1.06 ^{ab}	3.40 ^{bcd}
T ₁₃	Un weeded Control (no Sampoorna)	2.20 ^{de}	0.80 ^c	3.00 ^e

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 13. Effect of tank mixed herbicides with Sampoorna on chlorophyll content in rice at heading stage

Treatments		Chlorophyll content mg g ⁻¹ of fresh weight		
		Chlorophyll a	Chlorophyll b	Total Chlorophyll
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	2.74 ^b	1.23 ^a	3.97 ^{ab}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	2.64 ^{bc}	1.17 ^{ab}	3.82 ^{abc}
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	1.98 ^e	0.63 ^d	2.61 ^f
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	2.56 ^{bc}	1.06 ^{abc}	3.62 ^{cd}
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	2.57 ^{bc}	1.08 ^{abc}	3.66 ^{bcd}
T ₆	Bispyribac sodium @ 0.03 kg/ ha	2.59 ^{bc}	0.99 ^{bc}	3.58 ^{cde}
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	2.49 ^{cd}	1.06 ^{abc}	3.55 ^{cde}
T ₈	2,4-D Na salt @ 0.8 kg/ ha	2.53 ^{cd}	1.11 ^{abc}	3.64 ^{bcd}
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	2.44 ^{cd}	1.01 ^{abc}	3.46 ^{de}
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	2.50 ^{cd}	0.97 ^{bc}	3.47 ^{cde}
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	2.99 ^a	1.09 ^{abc}	4.080 ^a
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	2.50 ^{cd}	0.90 ^c	3.40 ^{de}
T ₁₃	Un weeded Control (no Sampoorna)	2.35 ^d	0.90 ^c	3.25 ^e

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 14. Effect of herbicides tank mixed with Sampoorna on weed density (Nos./m²) at 30 days after transplanting

Treatments		Weed count at 30 DAT (No./m ²)			
		Grasses	Sedges	Broad leaf weeds	Total
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	2.38 ^{bc} (5.33)	1.28 ^b (1.33)	2.38 ^{cde} (5.33)	3.48 ^b (12.00)
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	1.76 ^{bc} (3.33)	0.70 ^b (0.00)	3.13 ^{bc} (9.33)	3.52 ^b (12.00)
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	2.08 ^{bc} (4.00)	0.70 ^b (0.00)	2.08 ^{de} (4.00)	2.91 ^{bc} (8.00)
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	1.56 ^{bc} (2.33)	0.99 ^b (0.66)	3.13 ^{bc} (9.33)	3.57 ^b (12.33)
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	1.91 ^{bc} (4.00)	0.99 ^b (0.66)	3.33 ^b (10.66)	3.95 ^b (15.33)
T ₆	Bispyribac sodium @ 0.03 kg/ ha	2.20 ^{bc} (4.66)	0.70 ^b (0.00)	2.85 ^{bcd} (8.00)	3.56 ^b (12.66)
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	2.65 ^{ab} (6.66)	0.70 ^b (0.00)	2.65 ^{bcd} (6.66)	3.67 ^b (13.33)
T ₈	2,4-D Na salt @ 0.8 kg/ ha	1.91 ^{bc} (4.00)	0.70 ^b (0.00)	2.08 ^{de} (4.00)	2.90 ^{bc} (8.00)
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	1.93 ^{bc} (4.00)	0.99 ^b (0.66)	3.03 ^{bc} (9.33)	3.70 ^b (14.00)
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	1.94 ^{bc} (3.33)	0.99 ^b (0.66)	3.12 ^{bc} (9.33)	3.71 ^b (13.33)
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	1.28 ^c (1.33)	0.70 ^b (0.00)	1.761 ^e (2.66)	2.08 ^c (4.00)
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	1.46 ^{bc} (2.00)	0.99 ^b (0.66)	1.76 ^{de} (2.66)	2.31 ^c (5.33)
T ₁₃	Un weeded Control (no Sampoorna)	5.07 ^a (25.33)	4.06 ^a (16.00)	4.74 ^a (22.00)	7.98 ^a (63.33)

* $\sqrt{x+0.5}$ transformed values, original values in parentheses. In a column, means followed by common letters do not differ significantly at 5% level in DMRT

Table 15. Effect of herbicides tank mixed with Sampoorna on weed density (Nos./m²) at 60 days after transplanting

Treatments		Weed count at 60 DAT (No./m ²)			
		Grasses	Sedges	Broad leaf weeds	Total
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	2.65 ^{bc} (6.66)	1.61 ^{bc} (2.66)	3.61 ^b (12.66)	4.70 ^b (22.00)
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	2.22 ^{bc} (4.66)	0.99 ^{bc} (0.66)	2.12 ^{de} (4.00)	3.10 ^{cde} (9.33)
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	3.24 ^b (10.33)	0.70 ^c (0.00)	3.33 ^{bc} (10.66)	4.61 ^b (21.00)
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	1.76 ^{bc} (2.66)	0.99 ^{bc} (0.66)	2.12 ^{de} (4.00)	2.79 ^{de} (7.33)
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	1.76 ^{bc} (2.66)	0.99 ^{bc} (0.66)	2.40 ^{de} (5.33)	3.00 ^{de} (8.66)
T ₆	Bispyribac sodium @ 0.03 kg/ ha	2.25 ^{bc} (6.33)	0.70 ^c (0.00)	3.14 ^{bc} (10.00)	3.92 ^{bcd} (16.33)
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	2.05 ^{bc} (4.66)	1.76 ^{bc} (2.66)	3.42 ^{bc} (11.33)	4.32 ^{bc} (18.66)
T ₈	2,4-D Na salt @ 0.8 kg/ ha	2.26 ^{bc} (6.00)	1.79 ^b (3.33)	3.42 ^{bc} (11.33)	4.50 ^b (20.66)
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	1.76 ^{bc} (2.66)	1.28 ^{bc} (1.33)	2.79 ^{cd} (7.33)	3.42 ^{bcd} (11.33)
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	2.02 ^{bc} (4.66)	0.99 ^{bc} (0.66)	3.19 ^{bc} (10.00)	3.97 ^{bcd} (15.33)
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	1.64 ^c (2.66)	1.17 ^{bc} (1.33)	2.12 ^{de} (4.00)	2.85 ^{de} (8.00)
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	1.17 ^c (1.33)	0.99 ^{bc} (0.66)	1.94 ^{de} (3.33)	2.31 ^c (5.33)
T ₁₃	Un weeded Control (no Sampoorna)	5.14 ^a (26.00)	2.91 ^a (8.00)	8.68 ^a (75.00)	10.46 ^a (109.00)

* $\sqrt{x+0.5}$ transformed values, original values in parentheses. In a column, means followed by common letters do not differ significantly at 5% level in DMRT

Table 16. Effect of herbicides tank mixed with Sampoorna on weed density (Nos./m²) at harvest

Treatments		Weed count at harvest (No./m ²)			
		Grasses	Sedges	Broad leaf weeds	Total
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	3.33 ^{bcd} (10.66)	2.03 ^{*NS} (5.33)	4.87 ^{cde} (24.00)	6.25 ^{bc} (40.00)
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	3.19 ^{bcd} (10.00)	1.29 (1.33)	5.45 ^{bc} (29.33)	6.40 ^{bc} (40.66)
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	3.43 ^{bc} (11.33)	1.47 (2.00)	5.38 ^{bc} (28.66)	6.49 ^{bc} (42.00)
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	3.33 ^{bcd} (10.66)	2.02 (4.00)	5.43 ^{bc} (29.33)	6.66 ^{bc} (44.00)
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	3.33 ^{bcd} (10.66)	1.76 (2.66)	4.42 ^{de} (19.33)	5.74 ^c (32.66)
T ₆	Bispyribac sodium @ 0.03 kg/ ha	3.24 ^{bcd} (10.00)	2.49 (7.33)	5.33 ^{bc} (28.00)	6.75 ^{bc} (45.33)
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	2.85 ^{bcdde} (8.00)	0.99 (0.66)	5.07 ^{bcd} (25.33)	5.85 ^{bc} (34.00)
T ₈	2,4-D Na salt @ 0.8 kg/ ha	3.61 ^b (12.66)	1.61 (2.66)	4.63 ^e (17.33)	5.75 ^c (32.66)
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	2.57 ^{de} (6.66)	2.16 (5.33)	4.88 ^{cde} (23.33)	5.97 ^{bc} (35.33)
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	3.12 ^{bcd} (9.33)	2.78 (7.33)	5.75 ^b (32.66)	7.04 ^b (49.33)
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	2.26 ^c (4.66)	1.65 (4.00)	3.75 ^f (10.66)	4.39 ^d (19.33)
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	2.67 ^{cde} (6.66)	2.12 (5.33)	4.73 ^{de} (18.00)	5.48 ^{cd} (30.00)
T ₁₃	Un weeded Control (no Sampoorna)	4.94 ^a (24.00)	4.06 (16.00)	6.56 ^a (42.66)	9.11 ^a (82.66)

* $\sqrt{x+0.5}$ transformed values, original values in parentheses. In a column, means followed by common letters do not differ significantly at 5% level in DMRT

*NS: Non Significant

Table 17. Effect of herbicides tank mixed with Sampoorna on weed dry matter production (kg/ ha)

Treatments		DMP+ 30 DAT	DMP 60 DAT	DMP at harvest
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	78 ^b	157 ^{bc}	166 ^b
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	79 ^b	160 ^{bc}	203 ^b
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	78 ^b	152 ^{bc}	170 ^b
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	78 ^b	154 ^{bc}	173 ^b
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	75 ^{bc}	155 ^{bc}	173 ^b
T ₆	Bispyribac sodium @ 0.03 kg/ ha	79 ^b	135 ^{bc}	150 ^b
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	70 ^{bcd}	167 ^b	187 ^b
T ₈	2,4-D Na salt @ 0.8 kg/ ha	87 ^b	144 ^{bc}	160 ^b
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	91 ^b	140 ^{bc}	180 ^b
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	91 ^b	133 ^{bc}	177 ^b
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	43 ^{cd}	47 ^c	163 ^b
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	41 ^d	47 ^c	163 ^b
T ₁₃	Un weeded Control (no Sampoorna)	551 ^a	1240 ^a	1373 ^a

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

† Dry matter production

Table 18. Effect of herbicides tank mixed with Sampoorna on micronutrient content (mg/kg) at panicle initiation stage of rice

Treatments		Fe content (mg/kg)	Mn content (mg/kg)	Cu content (mg/kg)	Mo content (mg/kg)	Zn content (mg/kg)	B content (mg/kg)
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	974.50 ^{*NS}	1235.58 ^{cd}	7.750 ^{*NS}	2872.58 ^{*NS}	42.75 ^c	17.50 ^{*NS}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	889.41	1303.83 ^{bcd}	6.917	2695.00	45.00 ^{bc}	14.91
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	907.66	1530.75 ^{abc}	9.167	2598.33	42.91 ^c	23.58
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	1010.66	1348.91 ^{bcd}	7.183	2432.50	58.91 ^a	16.00
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	873.41	887.50 ^d	6.917	2393.33	49.08 ^{abc}	23.16
T ₆	Bispyribac sodium @ 0.03 kg/ ha	841.83	1219.83 ^{cd}	9.450	2611.66	49.58 ^{abc}	19.00
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	826.75	1224.00 ^{cd}	8.333	2423.33	38.50 ^c	25.75
T ₈	2,4-D Na salt @ 0.8 kg/ ha	983.41	1436.00 ^{abc}	9.250	2620.00	42.58 ^c	22.58
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	888.70	1736.91 ^{ab}	8.267	2528.33	48.66 ^{abc}	21.50
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	874.41	1046.00 ^{cd}	7.833	2855.83	46.00 ^{abc}	22.83
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	954.66	1879.58 ^a	7.417	3121.66	57.50 ^{ab}	28.91
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	1021.58	1362.08 ^{bcd}	8.000	2671.66	42.83 ^c	22.25
T ₁₃	Un weeded Control (no Sampoorna)	883.453	1217.33 ^{cd}	38.667	2643.33	40.58 ^c	18.91

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

*NS: Non Significant

Table 19. Effect of herbicides tank mixed with Sampoorna on nutrient uptake of rice (kg/ha) at harvest

Treatments		N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	205 ^{abc}	52 ^{ab}	227 ^{ab}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	216 ^{ab}	59 ^{ab}	230 ^a
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	157 ^e	48 ^b	165 ^d
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	181 ^{cde}	50 ^b	191 ^{cd}
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	192 ^{abcd}	59 ^{ab}	208 ^{abc}
T ₆	Bispyribac sodium @ 0.03 kg/ ha	198 ^{abc}	63 ^{ab}	206 ^{abc}
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	214 ^{ab}	54 ^{ab}	211 ^{abc}
T ₈	2,4-D Na salt @ 0.8 kg/ ha	164 ^{de}	56 ^{ab}	194 ^{bcd}
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	189 ^{bcd}	62 ^{ab}	207 ^{abc}
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	201 ^{abc}	64 ^{ab}	219 ^{abc}
T ₁₁	Hand weeding at 20& 40 DAT + Sampoorna	220 ^a	67 ^a	217 ^{abc}
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	198 ^{abc}	60 ^{ab}	226 ^{ab}
T ₁₃	Un weeded Control (no Sampoorna)	51 ^f	15 ^c	59 ^e

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 20. Effect of herbicides tank mixed with Sampoorna on pH, EC, organic carbon and available N P K content of soil after the experiment

Treatments		Soil pH	EC (dS/m)	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	6.47 ^{*NS}	0.20 ^{*NS}	1.63 ^{*NS}	531 ^{*NS}	32 ^{*NS}	210 ^{*NS}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	6.44	0.20	1.56	527	36	194
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	6.55	0.19	1.65	536	37	217
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	6.49	0.22	1.68	534	33	188
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	6.50	0.22	1.67	530	34	231
T ₆	Bispyribac sodium @ 0.03 kg/ ha	6.56	0.19	1.68	508	37	207
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	6.52	0.20	1.67	520	34	190
T ₈	2,4-D Na salt @ 0.8 kg/ ha	6.47	0.22	1.67	534	32	192
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	6.48	0.20	1.64	530	38	224
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	6.47	0.21	1.74	533	32	189
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	6.47	0.20	1.69	531	33	224
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	6.47	0.22	1.67	527	36	200
T ₁₃	Un weeded Control (no Sampoorna)	6.47	0.21	1.65	535	33	225

*NS: Non Significant

Table 21. Effect of herbicides tank mixed with Sampoorna on available micronutrients in soil after the experiment

Treatments		Available Fe (mg/kg)	Available Mn (mg/kg)	Available Cu (mg/kg)	Available Zn (mg/kg)	Available B (mg/kg)
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	126.13 ^{*NS}	219.80 ^{*NS}	3.96 ^{*NS}	8.42 ^{*NS}	0.26 ^{*NS}
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	136.60	198.56	5.16	9.07	0.30
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	126.80	168.70	4.35	8.69	0.36
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	128.13	209.16	4.45	8.77	0.33
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	162.73	258.46	5.31	8.97	0.41
T ₆	Bispyribac sodium @ 0.03 kg/ ha	133.11	196.23	4.68	9.32	0.37
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	160.66	260.90	5.24	9.76	0.28
T ₈	2,4-D Na salt @ 0.8 kg/ ha	211.16	209.98	4.35	9.00	0.29
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	135.20	213.91	5.04	8.70	0.37
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	112.60	192.26	5.15	8.43	0.44
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	168.73	230.10	4.70	8.82	0.28
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	161.83	212.77	4.61	8.47	0.35
T ₁₃	Un weeded Control (no Sampoorna)	134.31	231.40	4.48	8.94	0.28

*NS: Non Significant

Table 22. Effect of herbicides tank mixed with Sampoorna on weed control efficiency and percentage yield reduction

Treatments		WCE (%)			Percentage reduction in yield with respect to hand weeding+ Sampoorna
		30 DAT	60DAT	At harvest	
T ₁	Bispyribac sodium @ 0.03 kg/ ha + Sampoorna	85.72 ^{bcd}	87.32 ^b	87.45 ^a	4.25
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha + Sampoorna	85.54 ^{bcd}	87.30 ^b	85.15 ^a	0.68
T ₃	2,4-D Na salt @ 0.8 kg/ ha + Sampoorna	85.68 ^{bcd}	87.62 ^b	87.44 ^a	20.86
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna	85.67 ^{bcd}	87.47 ^b	86.89 ^a	13.52
T ₅	Cyhalofop butyl @ 0.08 kg/ ha + Sampoorna	86.23 ^{bc}	87.50 ^b	87.17 ^a	4.10
T ₆	Bispyribac sodium @ 0.03 kg/ ha	85.60 ^{bcd}	88.87 ^b	88.80 ^a	3.24
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15 kg/ ha	87.11 ^b	86.58 ^b	86.23 ^a	1.75
T ₈	2,4-D Na salt @ 0.8 kg/ ha	84.10 ^{cd}	88.27 ^b	88.45 ^a	6.47
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg/ ha	83.40 ^d	89.12 ^b	86.61 ^a	5.55
T ₁₀	Cyhalofop butyl @ 0.08 kg/ ha	83.29 ^d	88.96 ^b	86.89 ^a	0.45
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	92.04 ^a	96.11 ^a	87.97 ^a	0.68
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	92.53 ^a	96.23 ^a	87.79 ^a	-
T ₁₃	Un weeded Control (no Sampoorna)	-	-	-	74.08

Table 23. Effect of herbicides tank mixed with Sampoorna on economics of cultivation of rice

Treatments		Income from grain (Rs. / ha)	Income from straw (Rs. / ha)	Gross income (Rs. / ha)	Total Cost (Rs. / ha)	Net returns (Rs. / ha)	B:C ratio
T ₁	Bispyribac sodium @ 0.03kg ai/ha + Sampoorna	155154	44348	199502	86328	113174	2.30
T ₂	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15kg ai/ha + Sampoorna	160940	47070	208009	85968	122042	2.41
T ₃	2,4-D Na salt @ 0.8 kg ai/ha + Sampoorna	128231	35709	163940	85246	78694	1.92
T ₄	Metsulfuron methyl + Chlorimuron ethyl (premix) @ 0.004 kg ai/ha + Sampoorna	140125	40950	181075	88388	92688	2.05
T ₅	Cyhalofop butyl @ 0.08kg ai/ha + Sampoorna	155382	44177	199559	86638	112922	2.30
T ₆	Bispyribac sodium @ 0.03kg ai/ha	156779	46599	203377	85688	117690	2.37
T ₇	Cyhalofop butyl+ Penoxsulam (premix) @ 0.15kg ai/ha	159800	43176	202976	84688	118288	2.40
T ₈	2,4-D Na salt @ 0.8 kg ai/ha	151554	42463	194016	83966	110051	2.31
T ₉	Metsulfuron methyl+ Chlorimuron ethyl (premix) @ 0.004 kg ai/ha	153045	43765	196809	83888	112922	2.35
T ₁₀	Cyhalofop butyl @ 0.08kg ai/ha	161310	44785	206095	85358	120737	2.41
T ₁₁	Hand weeding at 20 & 40 DAT + Sampoorna	163077	45059	208136	117828	90309	1.77
T ₁₂	Hand weeding at 20& 40 DAT (without Sampoorna)	162051	45640	207691	115588	92104	1.80
T ₁₃	Unweeded Control (no Sampoorna)	40955	12273	53227	81198	-	0.65



Plate 3. Phytotoxicity of tank mix application of 2,4-D with Sampoorna on rice

5. DISCUSSION

A field experiment was carried out at Agricultural Research Station, Mannuthy in order to investigate the compatibility of Sampoorna with a few post emergence herbicides recommended for rice. Observations on phytotoxicity to crop, growth parameters, yield and weed control efficiencies were observed in order to study the antagonistic or synergistic effects of tank mixing herbicides with Sampoorna. The experimental results are discussed below.

5.1. Phytotoxicity to rice

Phytotoxicity is the adverse effect on plants upon exposure to foliar sprays. Symptoms such as necrosis, stunting, chlorosis and scorching indicate phytotoxicity and this can be accompanied by reduction in crop growth and yield. The degree of toxicity will vary with the chemical applied and rate of application. Majority of the herbicides recommended for rice are selective and hence safe for the crop at normal rates of application. Tank mixing of different compounds can lead to various physical and chemical interactions which may result in synergistic, antagonistic or neutral effects. Synergistic effect arises from positive interaction between chemicals mixed which indicates compatibility between them. Antagonism can result from negative interactions known as incompatibilities.

Chemical or physical incompatibilities between tank mixed compounds can arise resulting in undesirable effects like phytotoxicity which may affect the crop growth and yield adversely. Incompatibilities can lead to inefficiency of chemicals mixed. The crop was monitored for injury symptoms at 3 days after treatment application and again at 7 days after spraying.

Most of the tank mixed combinations of herbicides with Sampoorna were found to be safe to rice crop for foliar application. The sole applications did not result in toxicity as they are selective to rice. Saha (2006) confirmed absence of phytotoxicity of metsulfuron methyl+ chlorimuron ethyl in rice while Yadav *et al.* (2009) confirmed absence of residual toxicity of bispyribac sodium in rice. No phytotoxicity was noticed after the tank mixed application of cyhalofop butyl,

cyhalofop butyl+ penoxsulam, or bispyribac sodium with Sampoorna. Brown spots on leaves and yellowing were noticed when sprayed with tank mixed combination of Sampoorna with 2, 4-D sodium salt by third day itself. However, the phytotoxicity score reduced by 7 days after spraying as new leaves were free of toxicity symptoms. According to Atheena *et al.* (2016), tank mix application of carfentrazone-ethyl with cyhalofop butyl led to phytotoxicity in rice. They reported yellowing of leaf tips by the application of tank mix application of cyhalofop-butyl+ pendimethalin, indicating antagonistic effect due to chemical reaction between two herbicides.

Tank mix application of metsulfuron methyl+ chlorimuron ethyl or 2, 4-D salt with Sampoorna led to reduced plant height. Reduction in plant height in 2, 4-D+ Sampoorna was 17 % and 10 % at 30 and 60 days after transplanting respectively, compared to its sole applications. Spraying metsulfuron methyl+ chlorimuron ethyl+ Sampoorna resulted in 13 % and 6 % reduction at 30 DAT and 60 DAT respectively. By 60 days the percentage reduction in plant height was not very conspicuous, probably due to the fact that the effect was short term and plants continued normal growth.

In comparison to liquid formulations, dry formulations when tank mixed can lead to physical incompatibilities. Hence, powder formulations of herbicides 2, 4-D (soluble powder) and metsulfuron methyl+ chlorimuron ethyl (wetable powder) might have resulted in physical incompatibility when mixed with Sampoorna. Other herbicides used in the study were liquid suspensions (Table 4). Antagonistic effect in crop might have resulted from incompatibility of Sampoorna with 2, 4-D or metsulfuron methyl+ chlorimuron ethyl which affected cell division and crop growth and this was evident from data of plant height and other growth attributes. The phytotoxic effect can be attributed to the type of herbicide formulation also. Foaming, curdling, settling or layer formation of tank mixtures also were not noticed. All other herbicides were found to be compatible for tank mixing with Sampoorna with respect to phytotoxic effects.

5.2. Effect of tank mixing on plant height and tiller number

Tank mixed application of herbicides cyhalofop butyl, cyhalofop butyl+ penoxsulam, and bispyribac sodium with Sampoorna did not record any significant differences in plant height compared to their sole application. Contradictory to this, tank mix application of 2, 4-D with Sampoorna resulted in significant height reduction (Fig. 3). The reduction in height compared to sole application was 17 % at 30 DAT and 10 % at 60 DAT). A similar trend was followed by metsulfuron methyl+ chlorimuron ethyl when tank mixed with Sampoorna with 13 % and 6 % reduction in height at 30 DAT and 60 DAT respectively. Ali *et al.* (2004) observed reduced height in wheat sprayed with metribuzin or isoproturon+ diflufenicon. A general trend of reduced plant height and tiller number was noticed in sole application plots of metsulfuron methyl+ chlorimuron ethyl and 2, 4-D. In an experiment conducted by Reddy *et al.* (2021), significant reduction in number of tillers was noticed in rice sprayed with metsulfuron methyl+ chlorimuron ethyl compared to the tiller number registered in hand weeded plots. Antagonistic effect was prominent in 2, 4-D than metsulfuron methyl+ chlorimuron ethyl when tank mixed with Sampoorna. As all other herbicides were liquid formulations, solid formulations of 2, 4-D and metsulfuron methyl+ chlorimuron ethyl might have contributed to tank mix incompatibility with Sampoorna. The negative interaction of 2, 4-D and metsulfuron methyl+ chlorimuron ethyl with Sampoorna might have affected cell division, and eventually affected the cell elongation and plant height.

There was no significant variation between various treatments involving sole application of herbicides as well as hand weeding with respect to tiller number at 30 DAT as there was no severe competition from weeds to affect tillering. Tank mix application of 2, 4-D with Sampoorna resulted in significant reduction in number of tillering (40 % reduction) at 60 DAT with respect to its sole application. Similar trend was noticed when metsulfuron methyl+ chlorimuron ethyl was tank mixed with Sampoorna where reduction was 16 % at 60 DAT and 13 % at harvest. In rice tillering follows fibonacci series. Any shock

in early tillering phase will have negative influence on total number of tillers which in turn affect the number of productive tillers. The reduction in tiller count of tank mixed Sampoorna with 2, 4-D and metsulfuron methyl+ chlorimuron ethyl can be attributed to their phytotoxic effect at early stage of the crop.

At 60 DAT unweeded check registered comparable plant height to hand weeded plot and most of the treatments involving herbicides. Crop weed competition for light and space might have contributed to more plant height in unweeded plot. But in general, the crop health was poor. Comparable plant height in hand weeded and unweeded plots was recorded by Mandal *et al.* (2014), Amare *et al.* (2016), Atheena *et al.* (2016) and Reddy *et al.* (2021). Menon (2012) reported significantly higher plant height in unweeded control compared to hand weeded plot at 30 days after sowing, while at harvest plant height did not differ significantly among the treatments. However significant reduction in plant height was registered in unweeded plot at harvest compared to hand weeded plots. Luxurious weed growth suppressed crop growth and data of weed dry matter production indicates the severity of weed competition.

5.3. Effect of tank mixing on yield and yield attributes

Tank mixing with Sampoorna had no significant impact on number of productive tillers per hill for herbicides except 2, 4-D and metsulfuron methyl+ chlorimuron ethyl. Tank mix combinations of 2, 4-D or metsulfuron methyl+ chlorimuron ethyl with Sampoorna registered significantly lower number of productive tillers per hill compared to their sole applications. These two treatments registered a significant reduction in tiller number which ultimately affected number of productive tillers (Fig 7). Phytotoxicity and reduction in growth attributes in tank mixed applications of metsulfuron methyl+ chlorimuron ethyl or 2, 4-D with Sampoorna can be attributed to the reduced number of productive tillers. Possible chemical and physical incompatibilities of above-mentioned tank mixes and resultant decrease in growth parameters might have affected photosynthesis, assimilation and translocation of photosynthates. Unweeded control with high crop weed competition registered the lowest number

of productive tillers indicating severe crop weed competition affecting nutrient and water absorption, photosynthesis, nutrient assimilation and translocation, thus adversely affecting yield attributes.

Number of filled, unfilled, and total grains per panicle did not differ significantly among treatments except in the case of unweeded check. Test weight also had no significant variation among treatments. This is probably because of the fact that test weight is mostly a varietal characteristic which is decided by the genetic make-up rather than other factors as documented by many workers.

Grain yield and straw yield in treatments involving herbicides as well as hand weeded plots were comparable except in tank mixed application of 2, 4-D or metsulfuron methyl+ chlorimuron ethyl with Sampoorna. Crop phytotoxicity and resultant reduction in growth attributes and productive tillers affected grain yield and straw yield in tank mix application of 2, 4-D or metsulfuron methyl+ chlorimuron ethyl with Sampoorna. All other treatments involving herbicides as well as hand weeding registered comparable grain and straw yield. This indicates that tank mixing of Sampoorna with herbicides like bispyribac sodium, cyhalofop butyl+ penoxsulam, cyhalofop butyl *etc* is advisable. Comparable grain and straw yields in these treatments can be indicative of absence of any reaction or antagonistic effect. Perusal of data on grain yield indicate that no synergistic effect was there to tank mixing of herbicides with Sampoorna (Fig. 8).

Synergistic effects of tank mixing can result in higher grain yields. Tank mixing of urea with penoxsulam + cyhalofop butyl resulted in highest grain and straw yield of rice (Singh *et al.*, 2016). Reddy (2021) reported that tank mixing of cyhalofop butyl+ penoxsulam with metsulfuron methyl+ chlorimuron ethyl resulted in significant increase in rice grain yield compared to its sole application due to increased weed control efficiency.

Hand weeding resulted in comparable grain yield with treatments involving herbicides except tank mix application of 2, 4-D or metsulfuron methyl+ chlorimuron ethyl with Sampoorna. Contrary to this Atheena *et al* (2016), Jacob

et al (2014) and Prameela *et al* (2014) reported the highest grain yields in hand weeded plot than herbicide application plots. Generally, in hand weeded plots hundred percent weed free situation can result in higher yields than herbicide application. As by herbicide application weed population is kept below a threshold level and some lately germinated weeds can lead to some reduction in yield.

Percentage reduction in yield (in comparison with hand weeding+Sampoorna) was less than 10 percentage for all the treatments except unweeded control (74 percentage). Among tank mixed combinations, yield reduction was registered in tank mixed Sampoorna with either 2, 4-D or metsulfuron methyl+chlorimuron ethyl (21 % and 14 % respectively). Incompatibility of Sampoorna with the above-mentioned herbicides is evident from percentage yield reduction data. Crop phytotoxicity and resultant reduction in crop attributes might have contributed to lower grain yield in these treatments. Similar results were reported by Inalli *et al.* (2014) where application of atrazine+ oxyfluorfen followed by 2, 4-D and application of alachlor+ oxyfluorfen followed by 2, 4-D resulted to crop phytotoxicity and lower grain yields in rice.

5.4. Effect of tank mixing on chlorophyll content

Chlorophyll content in leaf was estimated at panicle initiation and heading stage. Sampoorna spray enhanced chlorophyll content compared to sole application of herbicides, except in the case of 2, 4-D. Same trend was noticed in hand weeded plots with Sampoorna application. Magnesium (Mg) ions in Sampoorna KAU multimix might have helped in increasing chlorophyll content in leaves as Mg is the principal element and central atom in chlorophyll. Supply of Mg ions can enhance chlorophyll a, chlorophyll b and total chlorophyll content in crops.

Crop phytotoxicity and yellowing in tank mixed application of 2, 4-D with Sampoorna affected the chlorophyll content in leaves. Reduction in chlorophyll content can be attributed to the possible chemical interaction between 2, 4-D and

Sampoorna leading to chemical incompatibility and ultimately phytotoxicity. According to Whitford *et al.* (2018), chemical incompatibility between tank mixing compounds may result in visual symptoms of crop injury within few hours to days of application. The reduction in chlorophyll content was not conspicuous at heading stage, this indicates revival of crop from phytotoxicity at this stage.

5.5. Effect of tank mixing on weed control efficiency

It was found that the tank mix combination of herbicides with Sampoorna resulted in good weed control efficiency as that of sole application of herbicides. Even the two combinations which led to phytotoxicity reduction in growth and grain yield, registered good weed control efficiency. This was due to the fact that though the combination spray was toxic to crop, the weed control efficiency was not affected. The weed control efficiency was the highest in hand weeding plots at all the stages of observation.

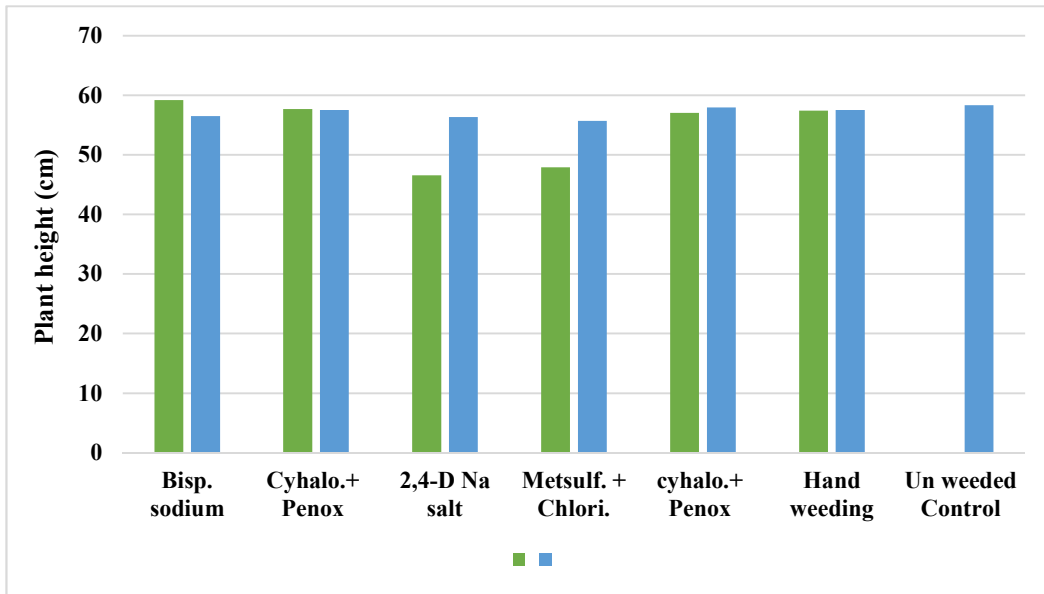


Fig. 3. Effect of tank mixing herbicides with Sampoorna on plant height (cm) of rice at 30 DAT

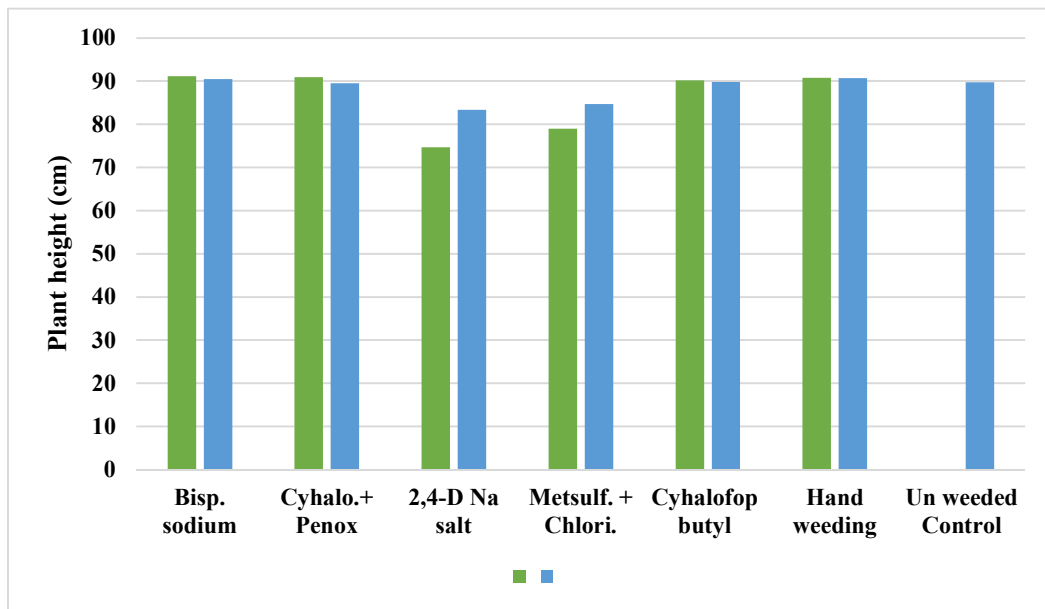


Fig. 4. Effect of tank mixing herbicides with Sampoorna on plant height (cm) of rice at 60 DAT

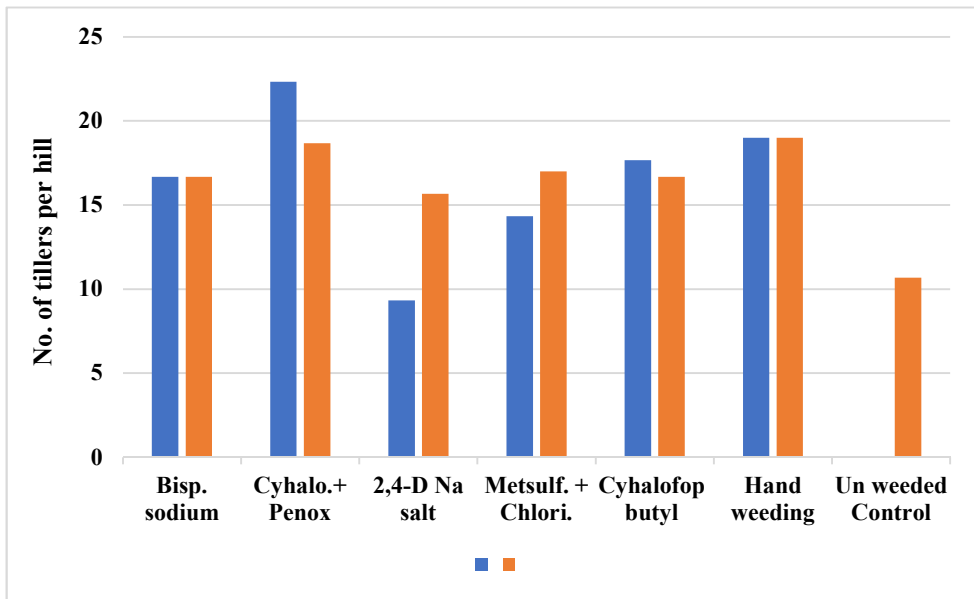


Fig. 5. Effect of tank mixing herbicides with Sampoorna on number of tillers of rice at 30 DAT

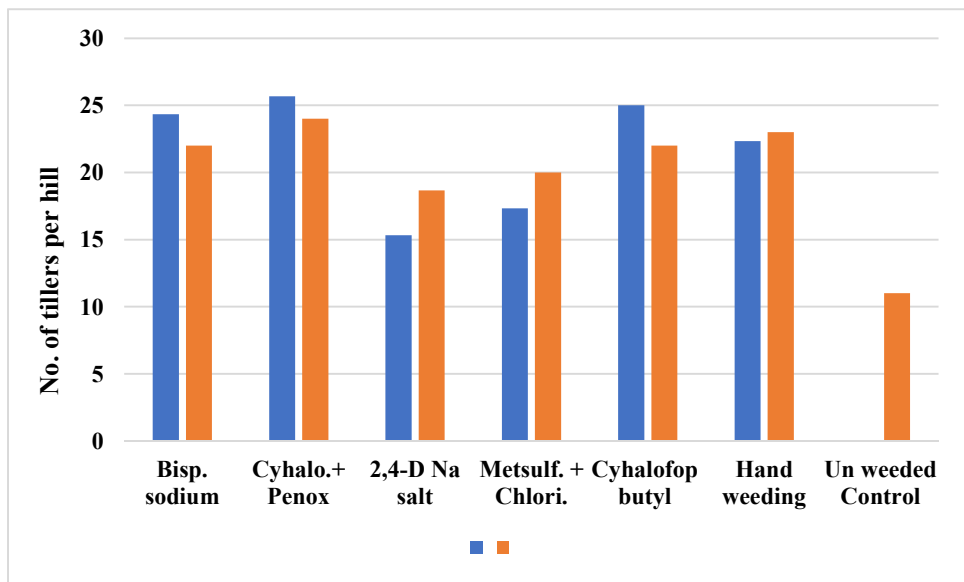


Fig. 6. Effect of tank mixing herbicides with Sampoorna on number of tillers of rice at 60 DAT

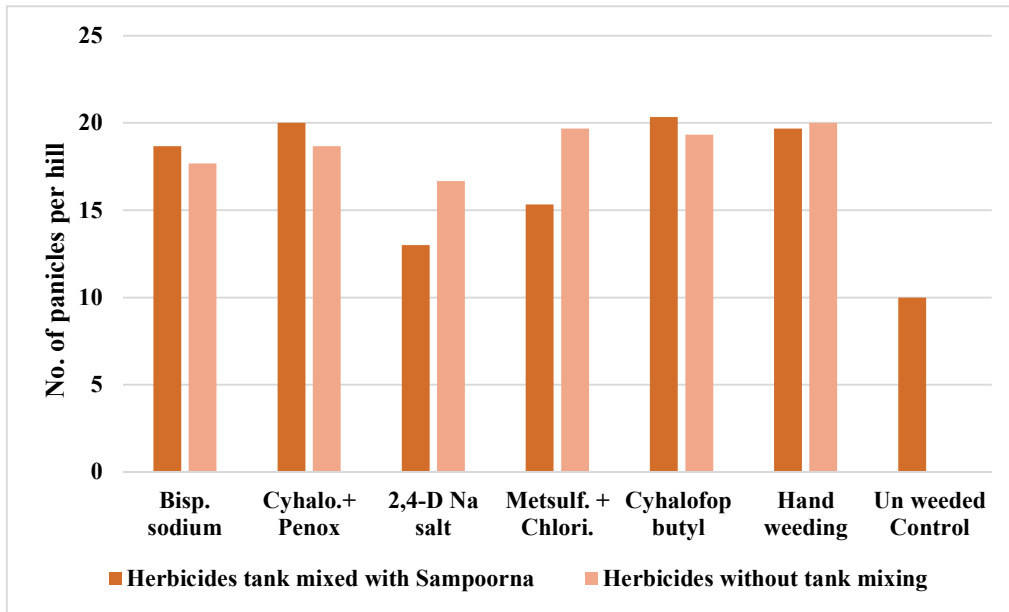


Fig. 7. Effect of tank mixing herbicides with Sampoorna on number of panicles (per hill) of rice

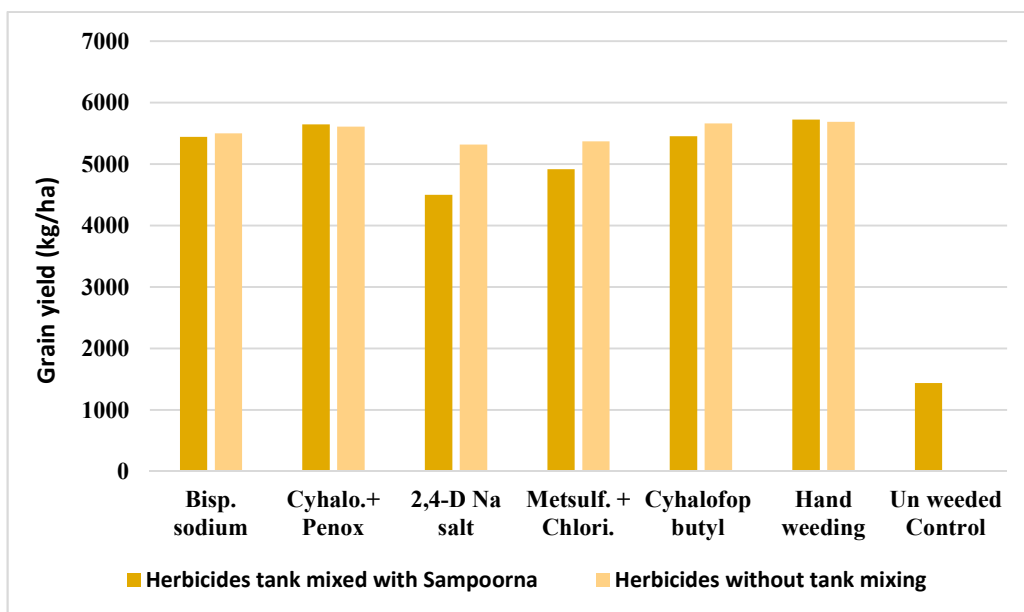


Fig. 8. Effect of tank mixing herbicides with Sampoorna on grain yield of rice

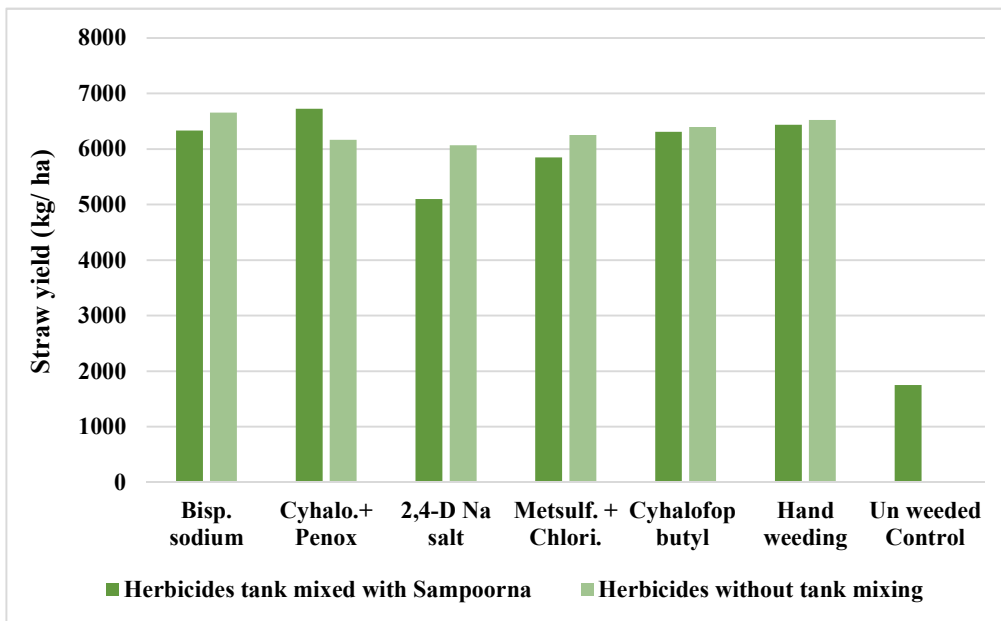


Fig. 9. Effect of tank mixing herbicides with Sampoorna on straw yield of rice

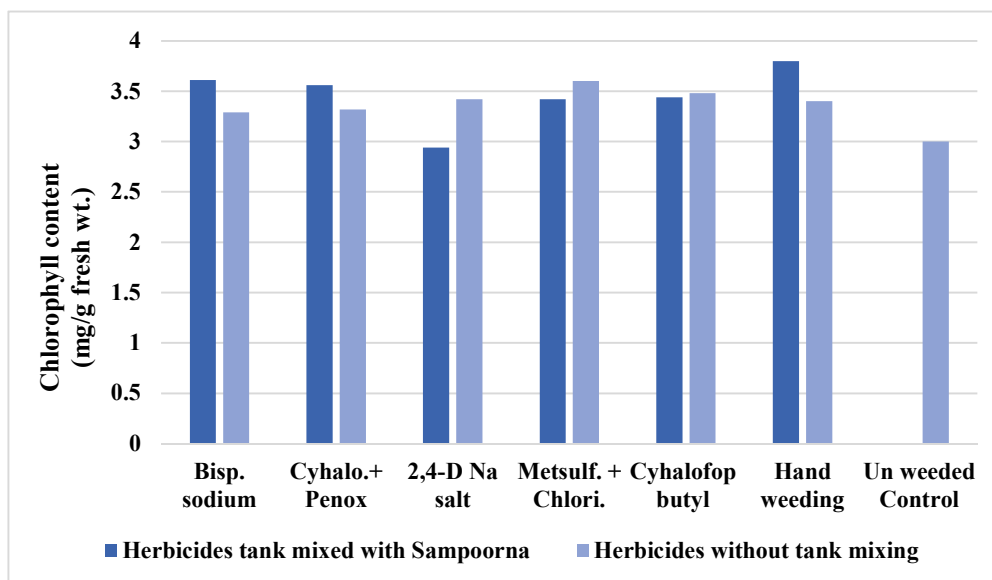


Fig. 10. Effect of tank mixing herbicides with Sampoorna on total chlorophyll content at PI stage of rice

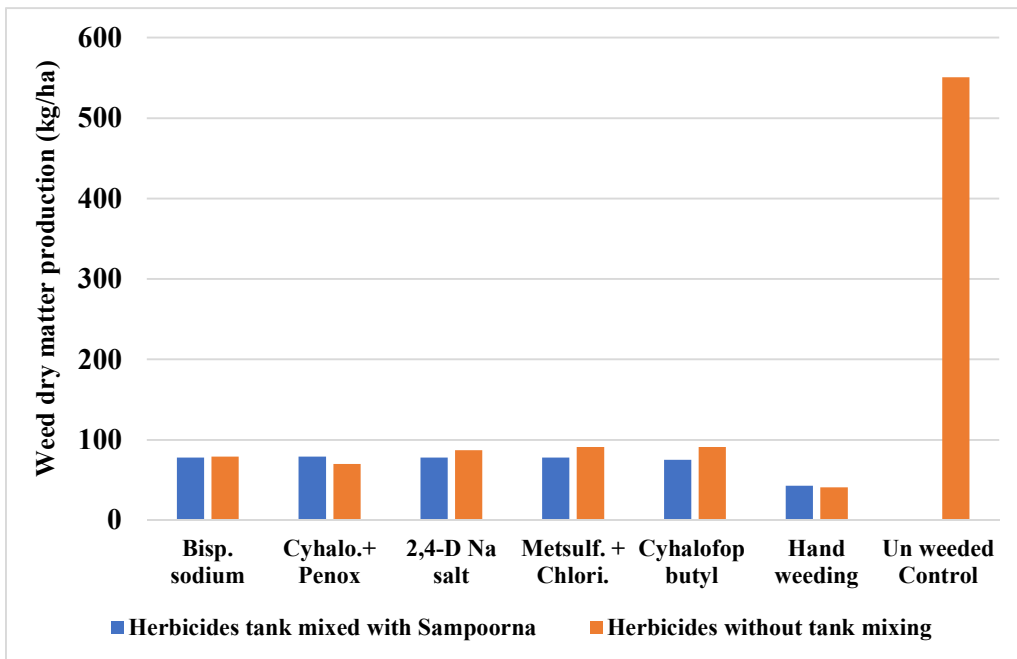


Fig. 11. Effect of tank mixing herbicides with Sampoorna on weed dry matter production (kg/ha) at 30 DAT

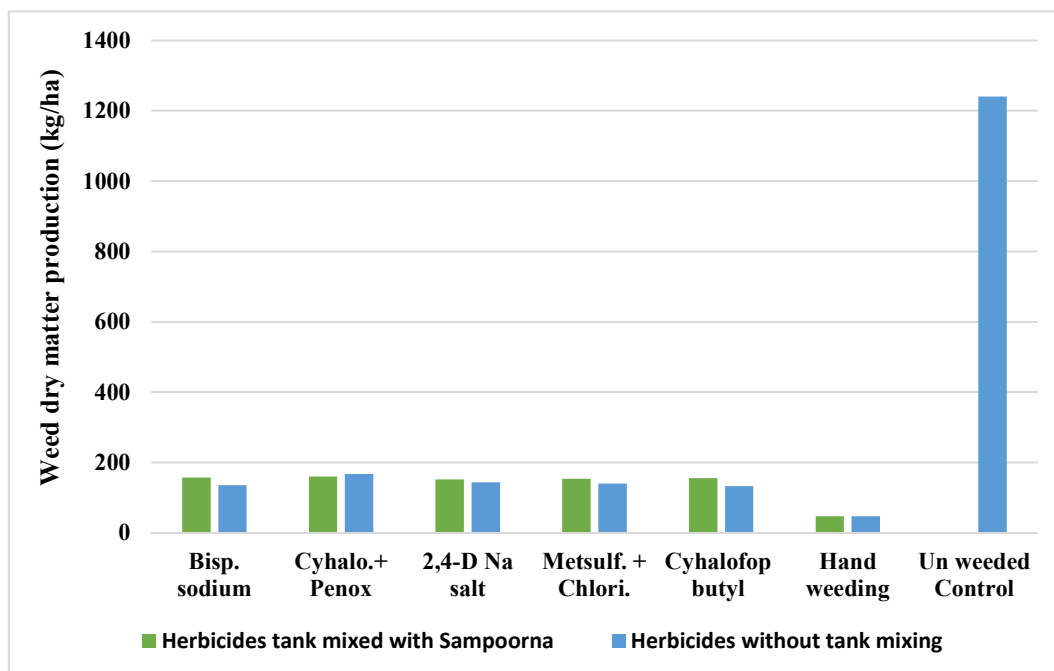


Fig. 12. Effect of tank mixing herbicides with Sampoorna on weed dry matter production (kg/ha) at 60 DAT

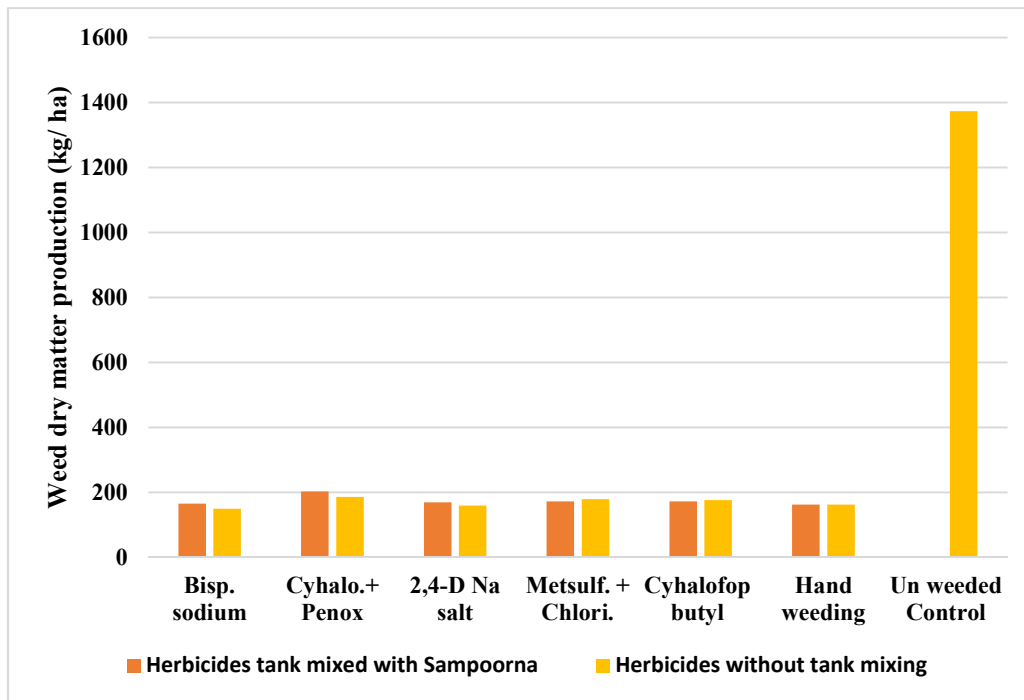


Fig. 13. Effect of tank mixing herbicides with Sampoorna on weed dry matter production (kg/ha) at harvest

SUMMARY

6. SUMMARY

Herbicides are an inevitable component in integrated weed management in rice. Tank mixing of agrochemicals is a practice among farmers to reduce cost involved and labour requirement. Unscientific and random mixing of agrochemicals can lead to incompatibilities and crop phytotoxicity. Hence, scientific information regarding compatibility of tank mixed chemicals is required to ensure efficacy.

A field experiment was conducted during 2022-2023 at Agricultural Research Station, Mannuthy, Kerala Agricultural University using the rice variety Uma (MO 16). The soil of the experimental field is sandy clay loam with a pH of 6.4. There were thirteen treatments, replicated thrice and the plot size was 5m x 4m. The treatments were bispyribac sodium @ 0.03 kg/ ha + Sampoorna (T₁), cyhalofop butyl+ penoxsulam(premix) @ 0.15 kg/ ha + Sampoorna (T₂), 2,4-D Na salt @ 0.8 kg/ ha + Sampoorna(T₃), metsulfuron methyl + chlorimuron ethyl (premix) @ 0.004 kg/ ha + Sampoorna (T₄), cyhalofop butyl @ 0.08 kg/ ha + Sampoorna (T₅), bispyribac sodium @ 0.03 kg/ ha (T₆), cyhalofop butyl+ penoxsulam (premix) @ 0.15 kg/ ha (T₇), 2,4-D Na salt @ 0.8 kg/ ha (T₈), metsulfuron methyl + chlorimuron ethyl (premix) @ 0.004 kg/ ha (T₉), cyhalofop butyl @ 0.08 kg/ ha (T₁₀), hand weeding at 20 & 40 DAT + Sampoorna (T₁₁) , hand weeding at 20 & 40 DAT (without Sampoorna) (T₁₂) and un weeded control plot (T₁₃). The crop was transplanted 20 days after sowing in nursery. Tank mix application of herbicides and respective sole applications were carried out at 20 days after transplanting. Follow up spray of Sampoorna was done at 50 days after transplanting. Hand weeding was carried out twice at 20 and 40 days after transplanting in T₁₁ and T₁₂. Non-targeted weed species (grass weeds) were removed by hand weeding in T₃, T₄, T₈ and T₉ at these stages. The salient findings are summarized below.

- Tank mix application of 2,4-D with Sampoorna resulted to severe crop phytotoxicity which was reduced by seventh day after treatment application,

while all other treatments were free of phytotoxicity symptoms.

- Significant reduction in plant height was registered in tank mix application of 2,4-D or Metsulfuron methyl + chlorimuron ethyl with Sampoorna with respect to their sole application, while all other herbicides registered statistically comparable plant height when tank mixed with Sampoorna at all stages of observation.
- Significant reduction in tiller number was noticed in tank mixed application of 2,4-D or Metsulfuron methyl + chlorimuron ethyl with Sampoorna compared to their individual application at 60 DAT and at harvest. All other herbicides registered comparable tiller count on tank mixing with Sampoorna.
- Tank mix application of 2,4-D or Metsulfuron methyl + chlorimuron ethyl with Sampoorna registered significantly lower number of productive tillers with respect to their sole application. All other treatments (except unweeded control) registered comparable number of panicles on tank mixing with Sampoorna.
- All the herbicides except 2,4-D and Metsulfuron methyl + chlorimuron ethyl registered grain yield statistically comparable to respective sole application and with that of hand weeded plots. Tank mixed combinations of 2,4-D or Metsulfuron methyl + chlorimuron ethyl with Sampoorna registered significantly lower grain yield (4499 kg/ ha and 4917 kg/ ha respectively) compared to that registered in their sole applications (5318 kg/ ha and 5370 kg/ ha respectively).
- A straw yield of 6066 kg/ ha was registered in 2,4-D while its tank mixed application with Sampoorna registered significantly lower straw yield of 5101 kg/ ha. Rest of the herbicides and their respective tank mixed combinations registered straw yield statistically on par with each other.
- At PI stage, tank mix application of 2,4-D with Sampoorna resulted in significantly lower chlorophyll content in comparison with its sole application, while all other herbicides registered higher but comparable chlorophyll content on tank mixing with Sampoorna. Similar trend was

repeated at heading stage. Hand weeding + Sampoorna was the best treatment which registered significantly higher chlorophyll content of 3.80 mg/g

- Among all the treatments, higher nitrogen uptake at harvest was reported in hand weeding+ Sampoorna with 220 kg/ ha which was statistically comparable with most of the treatments. Among tank mixed combinations of herbicides the lowest N uptake of 157 kg/ ha was registered in 2, 4-D+ Sampoorna followed by 181 kg/ ha in metsulfuron methyl + chlorimuron ethyl with Sampoorna.
- All other treatments except unweeded control registered comparable P uptake values. The lowest P uptake was registered in unweeded control which was inferior to all other treatment applications.
- K uptake at harvest registered comparable values in most of the treatments. Among tank mixed combinations the lowest K uptake was registered in 2,4-D+ Sampoorna followed by tank mix application of metsulfuron methyl + chlorimuron ethyl with Sampoorna (191 kg/ ha).
- Hand weeded plots registered significantly higher weed control efficiencies with respect to other treatments which were statistically on par with each other. All herbicides registered comparable weed control efficiencies in comparison with their respective tank mix combination with Sampoorna at 60 DAT and harvest.
- Percentage yield reduction with respect to hand weeding + Sampoorna was recorded. Unweeded control was the inferior treatment with percentage yield reduction of 74.08 percent. Among tank mixed combinations of herbicides with Sampoorna, 2,4-D + Sampoorna registered higher yield reduction of 21 percentage. This was followed by metsulfuron methyl + chlorimuron ethyl + Sampoorna with 14 percentage yield reduction.

Tank mixing of herbicides bispyribac sodium, cyhalofop butyl and cyhalofop butyl+ penoxsulam (premix) were found to be compatible with Sampoorna. Hence, the above herbicides can be recommended for tank mix

application with Sampoorna KAU multimix to save cost and time involved in spraying. There is a need to undertake further studies in this line to know the compatibility of the multimix with other herbicides and plant protection chemicals used in crop production.

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Appendix -I

Weather data during the cropping period (from 10 July 2022 to 12 July 2022)

Week	Temperature (°C)		R.H (%)	Mean wind speed (km/hr)	Rainfall	
	Max	Min	Mean		Total (mm)	Rainy days
28 (Jul 10-Jul 16)	28.5	22.9	90	3	228.9	7
29 (Jul 17-Jul 23)	29.1	23.6	88	1.7	109.2	4
30 (Jul 24-Jul 30)	31.2	24.1	83	2	14	2
31 (Jul 31- Aug 6)	28.7	23.6	91	2.5	33.2	5
32 (Aug 7- Aug 13)	29.2	23.5	85	3.4	91.1	5
33 (Aug 14-Aug 20)	32	24.1	75	2.2	1	0
34 (Aug 21-Aug 27)	29.8	23.4	85	2	106	3
35 (Aug 28-Sep 3)	31.1	23.7	86	2.2	63	5
36 (Sep 4- Sep 10)	30	23.7	86	2.2	63	5
37 (Sep 11- Sep 17)	30.1	23.8	83	2.4	57.7	3
38 (Sep 18- Sep 24)	31.5	23.5	79	2.2	4.1	1
39 (Sep 25- Oct 1)	32.6	23.8	73	2	0.4	0
40 (Oct 2-Oct 8)	31.6	24.3	79	2.2	4.1	1
41 (Oct 9- Oct 15)	31.6	22.8	78	1.5	19.7	3
42 (Oct 16- Oct 22)	32	23.7	82	1.9	25.7	3
43 (Oct 23- Oct 29)	32.6	23.2	77	1.4	20.1	2
44 (Oct 30-Nov 5)	33	23.9	70	3.1	18.9	1
45 (Nov 6- Nov 12)	33.4	23.6	75	2	8.7	2
46 (Nov 13- Nov 19)	31.6	23.6	75	2	8.7	2

Appendix -II

Details of herbicides used in the experiment

Sl. No.	Herbicide	Trade name	Quantity/ ha	Amount (Rs./ha)
1	Bispyribac sodium	Nominee gold	300 ml	2250
2	Cyhalofop butyl+ penoxsulam	Vivaya	2491 ml	3113
3	2,4-D sodium salt	Salix	842 g	445
4	Metsulfuron ethyl+ chlorimuron ethyl	Almix	20 g	91
5	Cyhalofop butyl	Clincher	800 ml	1920

**COMPATIBILITY OF MULTINUTRIENT MIX
SAMPOORNA WITH HERBICIDES FOR RICE**

AKHILA P.

(2021-11-016)

ABSTRACT OF THE THESIS

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Abstract

Tank mixing of agrochemicals is a common practise among farmers in order to save labour, time and application cost. However, mixing is done without having a scientific knowledge on effect of tank mixing. Tank mixing of agrochemicals may result in synergistic, antagonistic, or neutral effects on efficacies of chemicals involved. Herbicidal weed control is very common in rice as it is the economically viable and easy method. Usually post emergence herbicides are applied at 15-20 days of sowing or transplanting. There is a possibility of tank mixed spraying if the herbicides are compatible with Sampoorna. Hence a research programme entitled “Compatibility of multinutrient mix Sampoorna with herbicides for rice” was conducted during July to November 2022 to evaluate the weed control efficiency and compatibility of few post emergence herbicides with Sampoorna KAU multimix in transplanted wetland rice.

Experiment consisted of thirteen treatments which included application of five herbicides at recommended rates (bispiribac sodium @ 0.03 kg/ ha, cyhalofop butyl @ 0.08 kg/ ha, 2,4-D @ 0.8 kg/ ha and premix herbicides Almix[®] (premix of metsulfuron methyl and chlorimuron ethyl) @ 0.004 kg/ ha and Vivaya[®] (premix of cyhalofop butyl and penoxsulam) @ 0.15 kg/ ha. Respective tank mixed applications with Sampoorna KAU multimix @ 10 g/L were also included along with hand weeded plots with or without Sampoorna and unweeded check. The design was RBD replicated thrice and the variety was Uma. Spraying was given 50 days after transplanting. Phytotoxicity to crop was observed third and seventh day after spraying. Growth and yield attributes of crop were studied and weed parameters like weed count and weed dry matter production were also recorded.

Phytotoxicity to rice was observed with tank mix application of 2,4- D+ Sampoorna. Brown spots on leaves and yellowing were noticed by third day itself. The symptoms reduced by 7 days after spraying as new leaves were free of toxicity. This also led to reduction in chlorophyll content at panicle initiation and

heading stages. The chlorophyll content at PI stage in 2,4-D + Sampoorna was 2.94 mg/g fresh weight whereas in 2,4-D alone spray it was 3.42 mg/g. In all other treatments Sampoorna application resulted in slight increase in chlorophyll content. In the case of Almix[®] + Sampoorna though visual phytotoxicity symptoms were not present, reduction in plant height was noticed. Reduction in plant height in 2, 4-D+ Sampoorna was 17 % and 10 % at 30 and 60 days after transplanting respectively, compared to its sole application. While Almix[®]+ Sampoorna resulted in 13 % and 6 % reduction at 30 DAT and 60 DAT respectively. Individual application of herbicides resulted in comparable tiller counts with respect to their Sampoorna- tank mixed applications except in the case of 2, 4-D and Almix[®] at 60 DAT. Similar trend was noticed in number of productive tillers, grain yield and straw yield where all herbicides except 2, 4-D and Almix[®] registered higher values with tank mixed application with Sampoorna. Grain yield in 2,4-D+ Sampoorna was 15 percent lower than 2,4-D alone and corresponding reduction in Almix[®]+ Sampoorna was 8 percent. In the case of bispyribac sodium, cyhalofop butyl and premix cyhalofop+ penoxsulam, the sole application and tank mix registered comparable grain and straw yields and the grain yield ranged from 5444 to 5647 kg/ ha.

Hand weeded plots registered the lowest weed dry matter at all stages. Sole application as well as tank mixed application of all herbicides were comparable in weed dry matter production and weed control efficiency. The weed dry matter in unweeded plot was 1373 kg/ ha whereas the values ranged from 150 kg/ha to 203 kg/ ha in all other treatments, indicating that tank mixing herbicides with Sampoorna has not adversely affected efficiency of herbicides.

With respect to effect of Sampoorna application on grain yield of rice, the effect was not very conspicuous as the soil experimental field was not deficient with respect to micro nutrient status. The grain yields in hand weeded plots as well as hand weeded+ Sampoorna were comparable with grain yield of 5686 kg/ ha and 5722 kg/ ha respectively. 2,4-D+ Sampoorna followed by Almix[®]

with Sampoorna registered yield reduction of 21 percent and 14 percent compared to hand weeding+ Sampoorna spray which registered higher yield of 5722 kg/ ha.

Among tank mixed combinations of herbicides and Sampoorna, 2, 4-D registered the lowest N and K uptake on tank mixing with Sampoorna followed by tank mix application of Almix[®] with Sampoorna. All other treatments registered comparable P uptake values except unweeded control, which was the inferior to others.

It can be concluded that few post emergence herbicides for rice weed control *ie*; bispyribac sodium, cyhalofop butyl and Vivaya[®] (premix of cyhalofop butyl and penoxsulam) can be recommended for tank mix application with KAU Sampoorna as foliar spray at 15-20 days after sowing or transplanting. 2,4-D and Almix[®] are not compatible with Sampoorna and hence are not suitable for tank mix application.